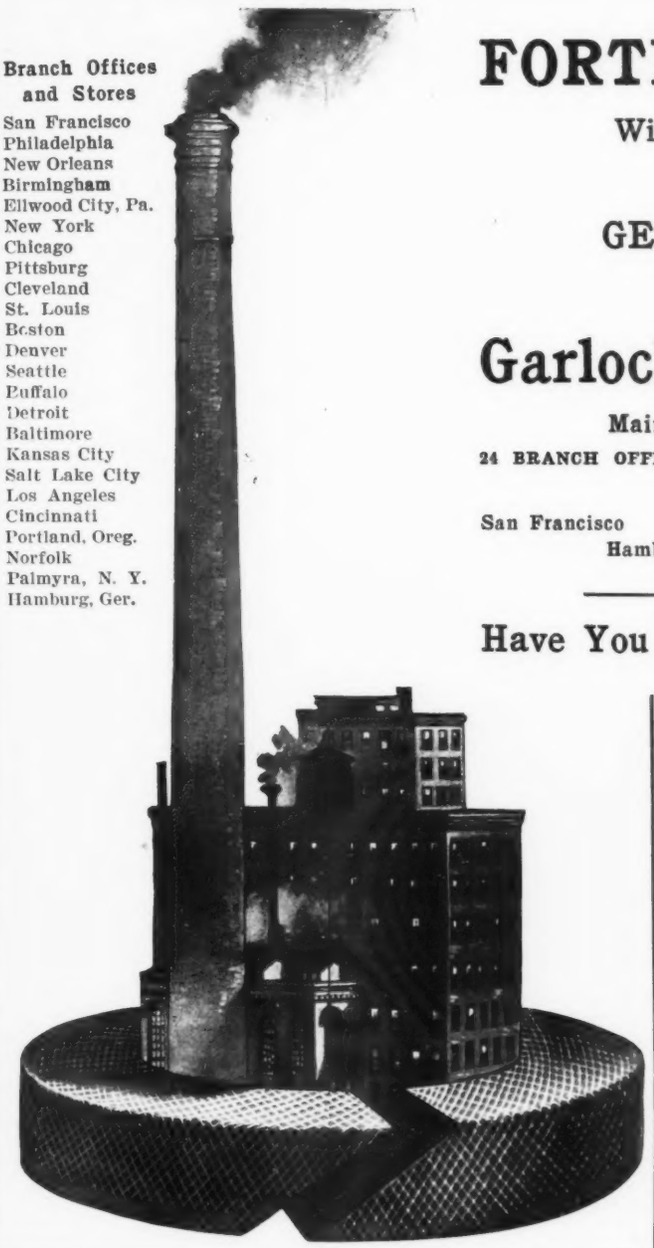
$2.00 per Year. JULY 7, 1908. Price 5 Cents.

POWER AND THE ENGINEER

ISSUED WEEKLY BY THE HILL PUBLISHING COMPANY, 505 PEARL STREET, NEW YORK.

Vol. 29 Index to Advertisers and Classified Index Following Readng Matter No. 1.

Branch Offices and Stores
San Francisco
Philadelphia
New Orleans
Birmingham
Ellwood City, Pa.
New York
Chicago
Pittsburg
Cleveland
St. Louis
Boston
Denver
Seattle
Buffalo
Detroit
Baltimore
Kansas City
Salt Lake City
Los Angeles
Cincinnati
Portland, Oreg.
Norfolk
Palmyra, N. Y.
Hamburg, Ger.



FORTIFY YOUR PLANT

With the Most Efficient Packings

In Other Words

GET YOUR PACKING FROM

The

Garlock Packing Company

Main Office and Factory, PALMYRA, N. Y.

24 BRANCH OFFICES AND STORES 5 BRANCH FACTORIES

BRANCH FACTORIES

San Francisco Denver New Orleans
Hamburg, Germany Ellwood City, Pa.

Have You a Copy of Our Latest Catalog?

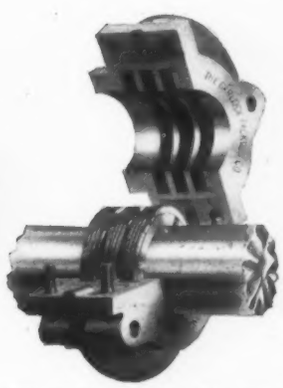
Oil Proof Sheet Style No. 153. For High Pressure Steam and Hot Water Service.

Metal and Fibrous Packings

In all forms for service against any class of conditions.

Garlock High Pressure Diagonal Ring. Style No. 107 Ring. For Worn Rods on High Pressure Service. This Packing Gives Very Satisfactory Results.

Garlock Rubber Insertion Extra Ring. Style No. 285.



Pitt Split Case Flexible Type Metal Packing Style No. 805.

? INTERESTED IN DIFFERENCES ?

Does it make any difference to you how much horse-power you get per pound of fuel consumed?

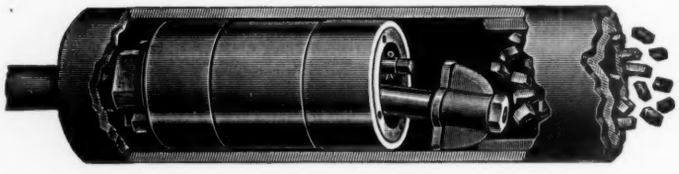
Does it make any difference to you how much time your fireman spends in firing?

Does it make any difference to you how much coal you burn?

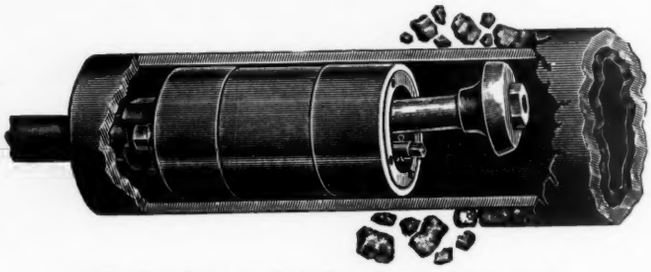
Does it make any difference to you how long your boilers last?

Does it make any difference to you how much time is spent in cleaning your boilers?

Does it make any difference to you what the first cost of scale fighters is?



The Dean Removing Scale From Water Tube Boilers.



The Dean Removing Scale From Return Tubular Boilers.

Does it make any difference to you how much you pay for repairs on scale fighters?

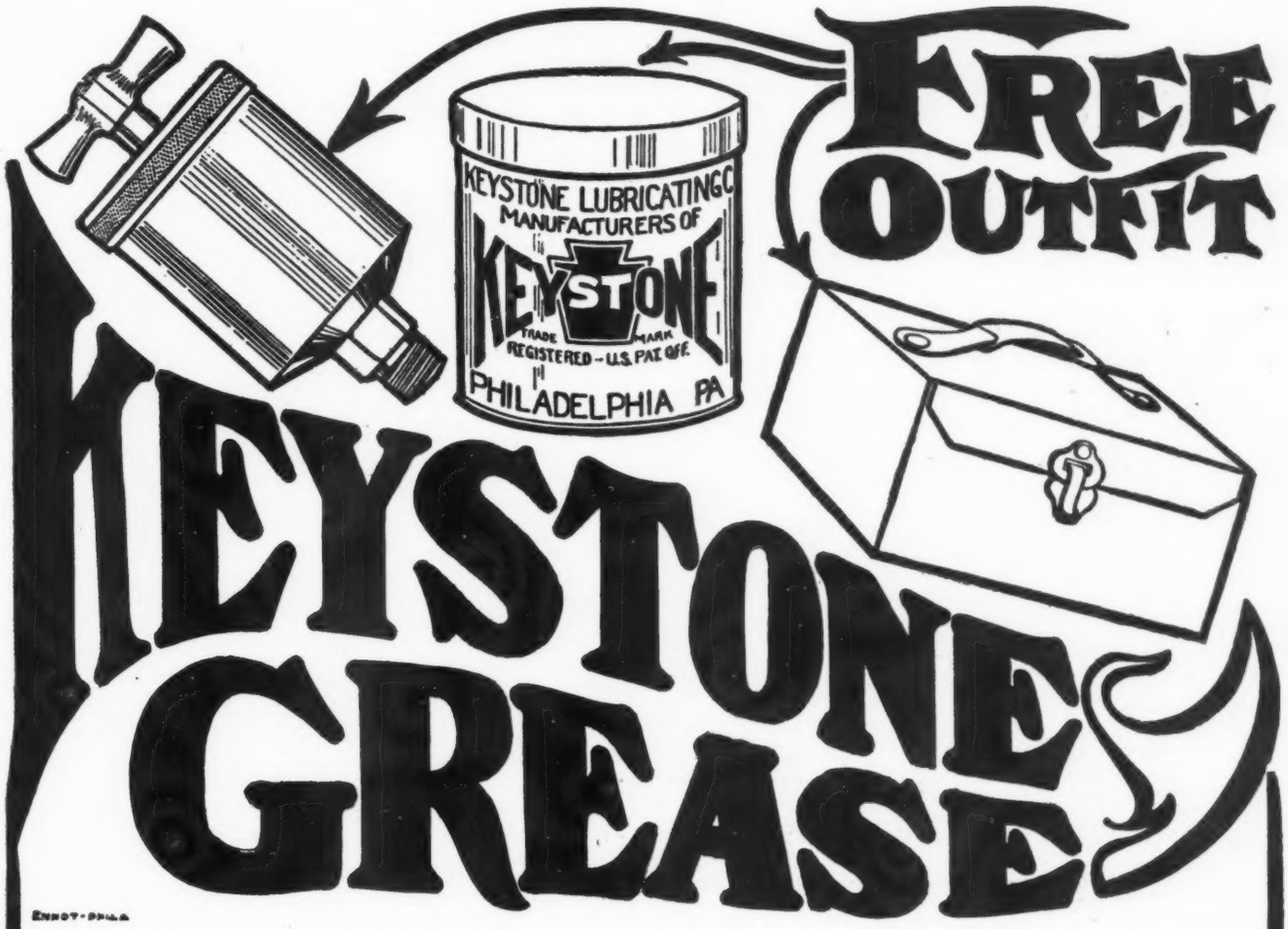
If it does, just write us and we'll send you a little booklet that will make you do some tall thinking. **"From Water To Steam."** It's written in plain, homely English, and it's chock full of truths, unblended, that the owner and operator of a boiler alike ought to know.

The Dean will point out the difference between the conditions that *should* be and the conditions that *are* in your boiler room. Shall we loan you a Dean to make this test in one boiler?

You'll be interested in Folder No. 6—write for it.

London Office,
13-15 Wilson Street,
Finsbury, London, E. C.

The Wm. B. Pierce Co.,
Jewett Building,
Buffalo, N. Y.



ENDOT-PHILA

NO HOT BEARINGS

annoy the engineer who uses KEYSTONE GREASE nor is he troubled by drippings from the cups in larger quantity than desired. KEYSTONE GREASE is "always there" and always right—no more than necessary but always enough.

We want every engineer to prove to himself that KEYSTONE GREASE is truly the World's Greatest Lubricant, and accordingly we will send **ABSOLUTELY FREE, EXPRESS CHARGES PAID**

A Large Can of KEYSTONE GREASE
A Fine Brass Grease Cup and an
Engineer's Collapsible Lunch Box

To any engineer who will fill out and mail to us the attached coupon.

There is no string to this proposition. We only ask that Keystone Grease be given a fair chance on your engines or auxiliaries to **PROVE ITS VALUE.**

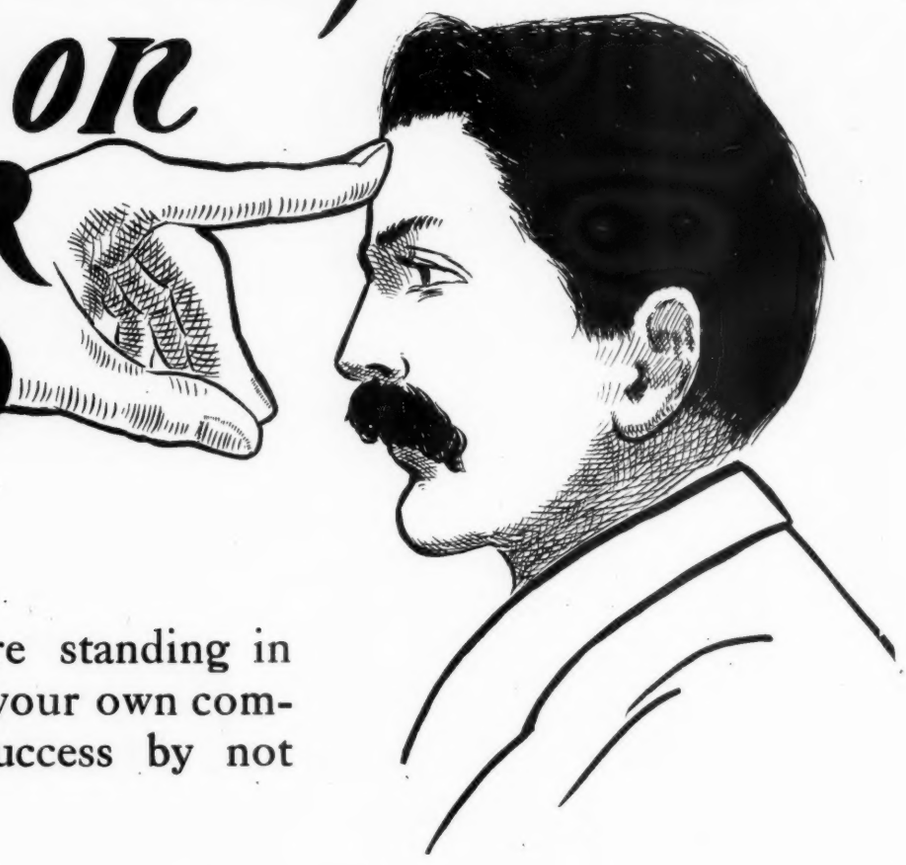
Don't wait, write today to the

KEYSTONE LUBRICATING CO.,
Dept. B. PHILADELPHIA, PA.

New England Office—10 Oliver St., Boston, Mass.
New York City Office—96 Warren Street.
Southern Office—610 Chartres St., New Orleans, La.
Chicago Office—1210 Tacoma Bldg.
Northwestern Agent and Warehouse—502 McPhee Bldg., Denver, Col.
San Francisco Agent and Warehouse—268 Market St., San Francisco, Cal.

Name.....
Name of Firm.....
.....
Address in Full.....
.....
.....
H. P. of Engine.....
On what bearing will sample be tested?
.....
Its width.....
R.P.M.....
Size of tap for cup.....
July 7-08, Dept. B

Let us impress this on YOUR MIND



that you are standing in the way of your own comfort and success by not using

Ebonite Black Sheet Packing

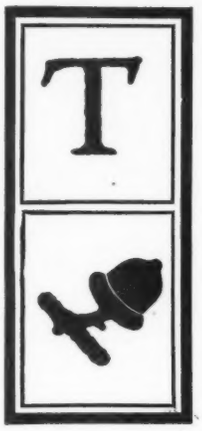
The best operated industrial plants in America use EBONITE. Long ago they discerned that of all the sheet packings, EBONITE alone could keep things going smoothly and inexpensively—as a plant should be run.

EBONITE first came into fame by its success in superheated steam joints. But for high steam, gas, oil, acids, water, etc., you will find it equally superior to all other packings. Give Ebonite a trial. You'll have less to worry about and the boss will think more of your ability.

Quaker City Rubber Company

Philadelphia and Chicago

The House of Dearborn



THERE is always one great pioneer and leader in the development of every important industry. Twenty years ago, the fact that great savings could be made in fuel consumption and that boilers and boiler tubes could be made to last much longer, but for the detrimental action of boiler feed waters, interested some young chemists in Chicago in the possibility of surmounting this difficulty by making careful analytical study of different classes of waters, and finding scientific reagents for the elements that produced the trouble.

Thus began the work of the DEARBORN COMPANY. That it has been successful is attested by the fact that thousands of steam plants use their products, prepared according to analysis of the waters, and find absolute relief from the troubles formerly experienced.

With its large corps of representatives, all of whom are *mechanical experts*, working in all sections of the country, backed by the scientific laboratory work done at Chicago, the Dearborn Company is able to give personal attention to every case, making careful study of the water and plant conditions and furnishing treatment that exactly meets requirements.

DEARBORN DRUG & CHEMICAL WORKS

ROBERT F. CARR, President.

W. B. McVICKER, Vice-Pres. & Gen. Mgr. | GEORGE R. CARR, Vice-Pres. | G. W. SPEAR, Vice-Pres.
W. A. CONVERSE, Asst. Sec. & Chem. Dir. | J. D. PURCELL, Asst. Gen. Mgr. | H. R. BROWNING, Asst. Treas.

POSTAL TELEGRAPH BLDG., CHICAGO. 299 BROADWAY, NEW YORK.

BRANCH OFFICES

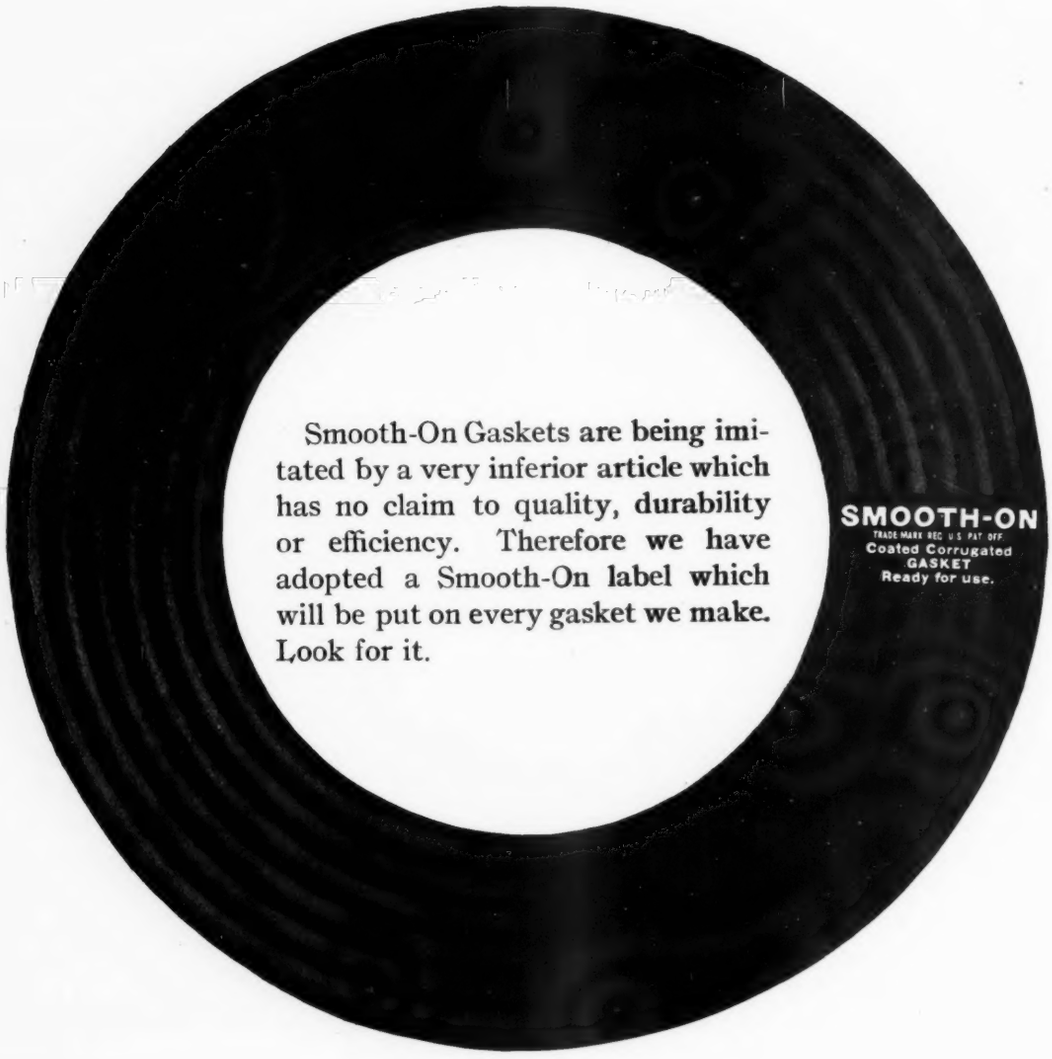
Philadelphia, The Bourse
Detroit, Majestic Building
Denver, Majestic Building
Boston, Oliver Building
Birmingham, First Nat. Bank Bldg.
Salt Lake City, Dooly Block
Pittsburg, House Building
St. Louis, Security Building
San Francisco, 301 Front Street
Buffalo, Morgan Building
Kansas City, New York Life Building
Milwaukee
Cleveland
Los Angeles, 255 E. Second Street
Cincinnati, Union Trust Building
St. Paul, 1237 Lincoln Avenue
Honolulu, 42 Queen Street
Havana, Esquina Mercaderes y Cortina de Valdes
Indianapolis
Peoria, Mayer Building

SMOOTH-ON
TRADE MARK-REG. U.S. PAT. OFF.
Coated Corrugated
GASKET
Ready for use.

THIS LABEL

SMOOTH-ON
TRADE MARK-REG. U.S. PAT. OFF.
Coated Corrugated
GASKET
Ready for use.

IS FOR YOUR PROTECTION


Smooth-On Gaskets are being imitated by a very inferior article which has no claim to quality, durability or efficiency. Therefore we have adopted a Smooth-On label which will be put on every gasket we make. Look for it.
SMOOTH-ON
TRADE MARK-REG. U.S. PAT. OFF.
Coated Corrugated
GASKET
Ready for use.

SMOOTH-ON
TRADE MARK-REG. U.S. PAT. OFF.
Coated Corrugated
GASKET
Ready for use.

Smooth-On Gaskets make joints for steam, air, water or oil that will always be tight.

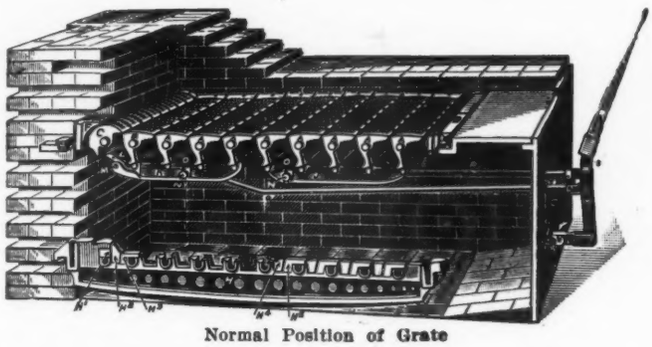
They have no equals.

SMOOTH-ON
TRADE MARK-REG. U.S. PAT. OFF.
Coated Corrugated
GASKET
Ready for use.

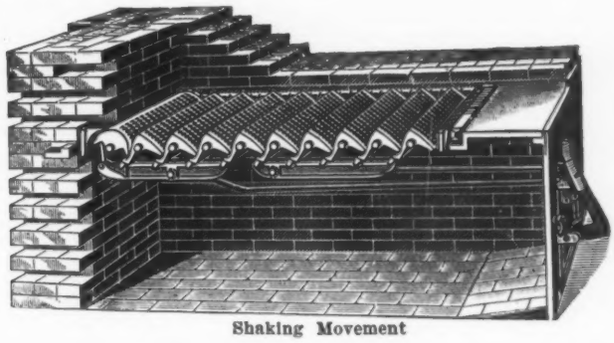
SMOOTH-ON MFG. CO.

572-574 Communipaw Avenue, JERSEY CITY, N. J., U. S. A.

Chicago Warehouse—61 N. Jefferson St. San Francisco Warehouse—94 Market St.



Normal Position of Grate



Shaking Movement

Argand Steam Blower

The Master Coal-Saving Combination

McClave Grate and Argand Blower

There is no greater economy possible in the power plant than that which comes from using cheap, low grade fuel—provided you have a grate that burns it with as good results as can be obtained from high grade coal.

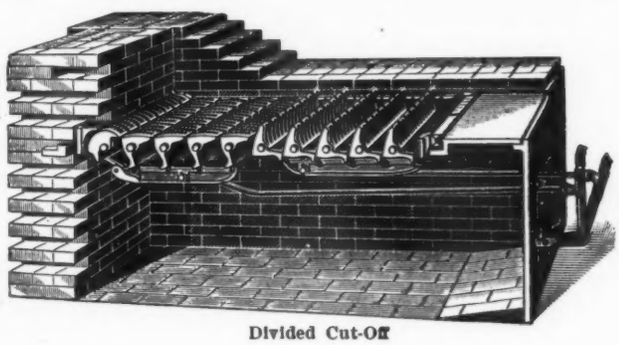
The system that gains that end, with its enormous saving, is the McClave Improved Grate and the Argand Blower. It secures perfect combustion of anthracite birdseye, rice, bituminous slack, screenings, duff, etc., and leaves no waste in the ash pit.

The illustrations herewith show the different cut-off movements. Let us tell you all the valuable features.

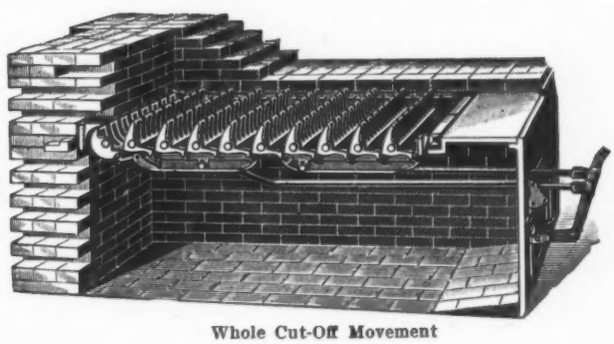
SEND FOR CATALOG "G"

McClave-Brooks Company, - - Scranton, Pa.

BRANCH OFFICES: Charles N. Hayes, Sales Agent, Fisher Bldg., Chicago; Empire Bldg., Pittsburg.



Divided Cut-Off



Whole Cut-Off Movement

SATISFACTION!

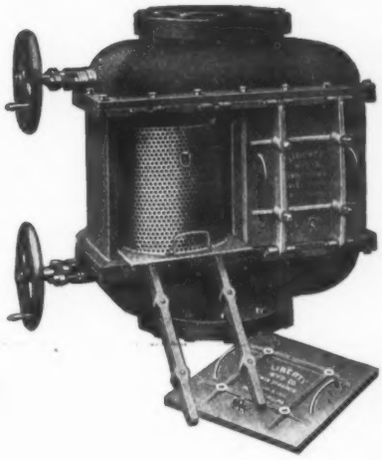
That is what you get with every
Lunkenheimer
Regrinding Valve.
The smallest detail is given careful consideration, making the valve as a whole the most durable and practical obtainable. Remember, that not only can the seat bearings be reground, but the disc can be renewed.
You can have a copy of our catalogue for merely the asking.

The Lunkenheimer Company

Largest Manufacturers of High Grade Engineering Specialties in the World
General Offices and Works, Cincinnati, Ohio, U.S.A.
Branches: New York, 66-68 Fulton St.; London, S. E., 35 Great Dover St.; Chicago, Lake and Dearborn Sts.
187

"LIBERTY" EXPENSE DESTROYERS

"Liberty" devices for the power plant work for highest possible efficiency and economy in the production of power. The large savings they make soon repay the cost of these appliances.

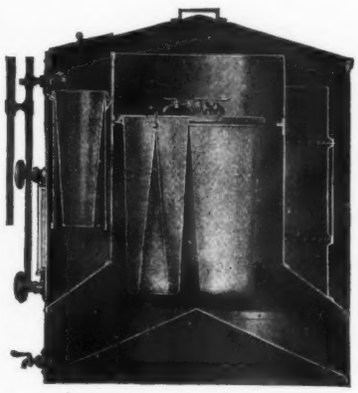


Liberty Turbine Cleaners

are the most powerful and effective tube cleaning devices ever made. A 4-inch 18-foot tube containing scale 1 inch thick is cleaned perfectly in 20 minutes, with no injury to tube, and with one man operating. Do you know any other that equals this?

Liberty Twin Strainer

should be used in all pressure or suction lines where there is foreign matter in the water supply. It strains thoroughly and continuously, can be cleaned easily and quickly under full pressure, and it absolutely prevents clogging.



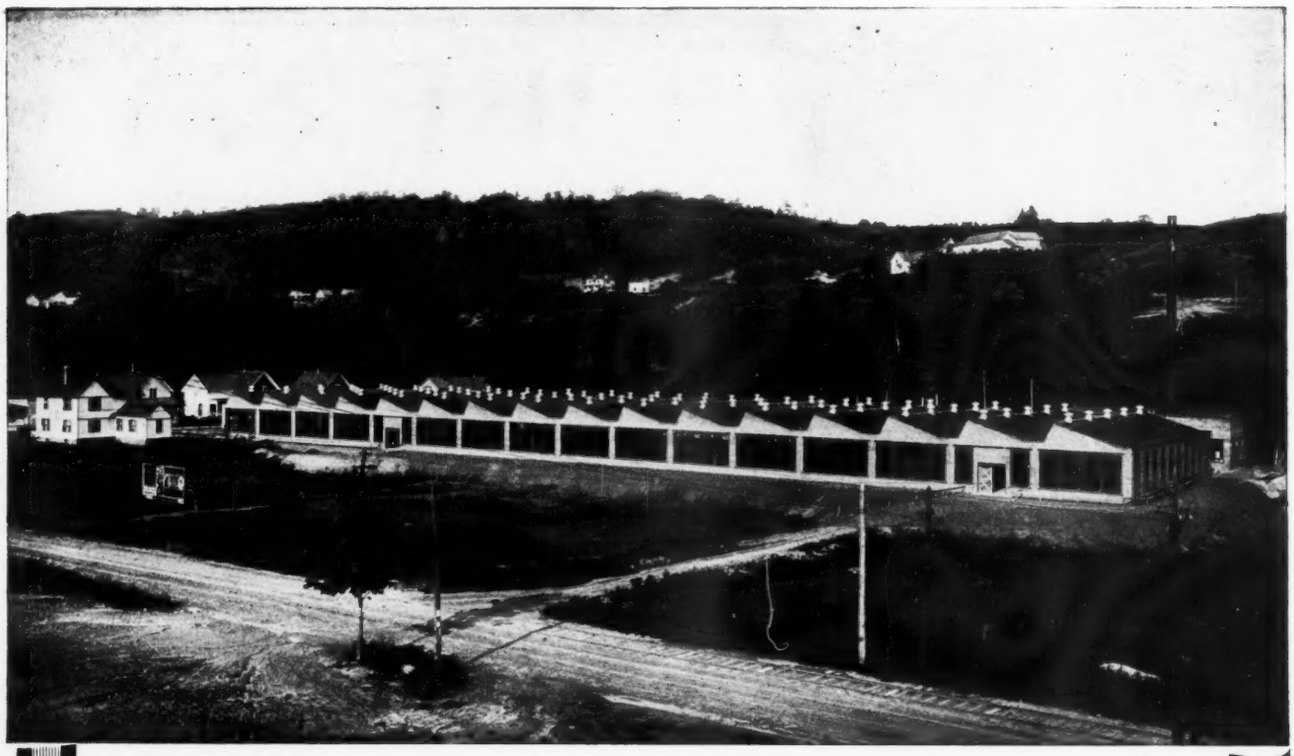
Liberty Oil Purifier

is the cheapest, simplest, most effective device known for purifying and refining used lubricating oil. It uses no hot water, bone dust, charcoal, or other injurious substances, and it saves practically all the oil.

Send for the Catalogs.

LIBERTY MFG. CO.,

6509 Susquehanna St., Pittsburg, Pa.

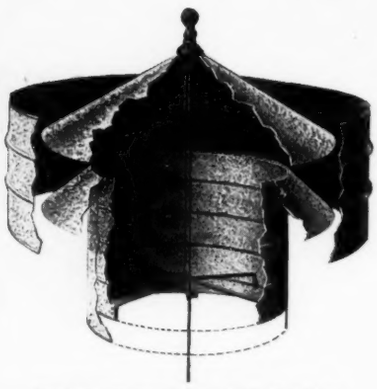


80 Burt Ventilators

are used on the new plant of the Jones & Lamson Machine Co., at Springfield, Vt., and this is only one of the many large installations of "Burts" in this country.

Burt Ventilators are made of extra heavy galvanized iron, they are strong, durable, neat in appearance and absolutely storm-proof. They can be had with either metal or glass tops, the latter serving also as skylights which can be closed against the weather without shutting out the light—only ventilator on the market having this feature. They require no expense for operation and no attention.

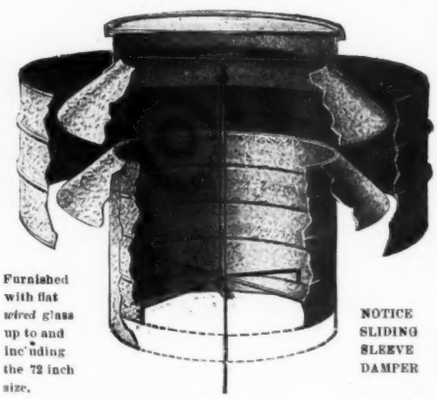
The Nordberg Mfg. Co , uses 48 Burt Ventilators; The Florida East Coast Ry., 48; The Babcock & Wilcox Boiler Co., 60. Other names of users upon request.



Metal top with sliding sleeve damper (patented).

Send for our 92-page Catalog.

George W. Reed & Co., Montreal, Sole Manufacturers of "Burt" Ventilators for Canada.



Furnished with flat wired glass up to and including the 72 inch size.

NOTICE SLIDING SLEEVE DAMPER

THE BURT MFG. CO., 232 Main St., Akron, O., U. S. A.

Largest Manufacturers of Oil Filters in the World.

Setting the Valves of the Wright Steam Engine

Plain Directions, Illustrated with Diagrams, for Setting the Gridiron Valves with Which These Old-time Engines are Provided

BY HUBERT E. COLLINS

Wright engines were designed and built by the late William Wright and many of them are still in use throughout the country. During the many years of his activity in the engine field, Mr. Wright designed a number of different types of valve and valve motion for his steam engines. In the rotary-valve engines there were several modifications in the driving mechanism and of the flat or gridiron valves there were several different shapes of valve and port, but in the latter case the driving mechanisms were all practically the same in detail and principle. As there are a large number of Wright engines in daily operation, an explanation of the setting of the gridiron valve should prove of general interest.

Figs. 1 and 2 give views of the steam and exhaust sides, respectively, of a Wright automatic cut-off engine with four gridiron valves direct-driven from one eccentric. In both these figures the eccentric is indicated by *A*, and the eccentric-rod is shown at *B*, Fig. 2. The rock-shaft *D D'* extends under the engine frame from side to side, and on each end of the shaft are shown the rocker-arms. In Fig. 1, *E* represents the hook-rod; *F*, the steam wrist-plate; *G G*, the steam valve-rods; *H H*, the steam valve-cranks; *I I*, the steam valve-stems and yokes, and *J J* are the steam-chest covers. The same parts relating to the exhaust are indicated by the same letters primed.

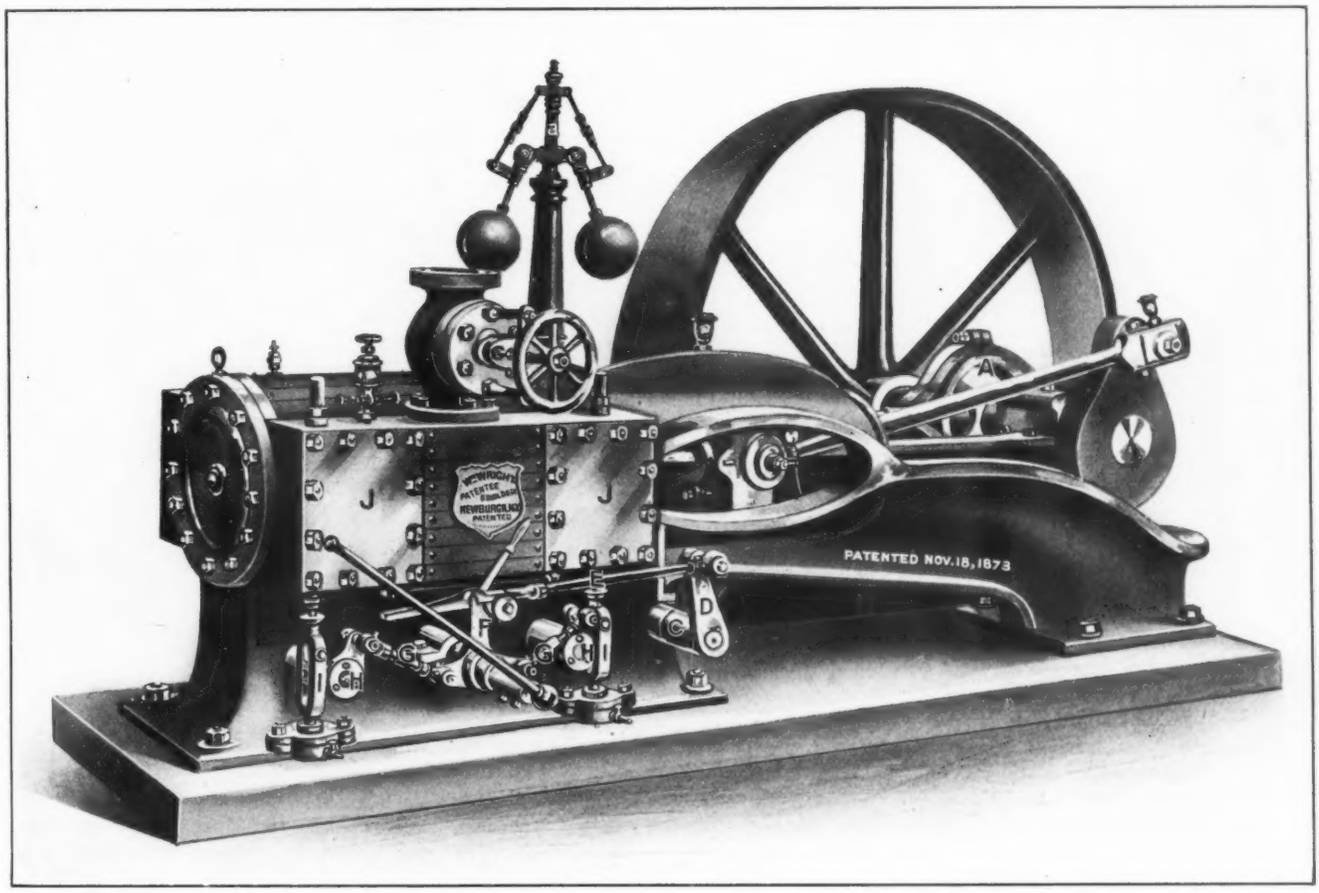


FIG. 1. STEAM SIDE OF WRIGHT AUTOMATIC CUT-OFF ENGINE

Valves and Valve Movement

Regulation is effected by a pendulum governor, which is shown in the two illustrations just referred to. When the governor is in operation, the balls revolve around the central axis, and as they rise, lift the vertical rod *a*, the lower end of which is shown at *b*, Fig. 2, where it is attached to the arm *c* which actuates the rock-shaft *d*. To this shaft are attached the arms *e e*, which draw the splined spindle through the hollow rock-shaft.

Both the steam and exhaust valves work vertically and are actuated by valve-stems extending downward through stuffing boxes in the bottoms of the chests. The steam and exhaust wrist-plates are keyed to one shaft, which extends under the cylinder from one side to the other, so that they operate at the same time, when motion is imparted by the hook-rod *E*. The two shafts which carry the valve-cranks are hollow and stationary, each having one steam and one exhaust crank

on their respective ends. The main steam valve-stems are fastened into the yokes with set-screws, and on their lower ends the yokes are provided with dash-pots, which also act as guides. The yokes are operated by steel slides which are fitted into the hollow valve-crank and act on the toes held in the yoke. In the exhaust valve-yokes are provided sliding blocks to which the valve-cranks are secured by a pin, the block allowing the pin center to change its position horizontally as it moves vertically.

Of the four gridiron valves with which the Wright engines are provided, two steam and two exhaust valves, one of each is placed on one side of the cylinder and a similar pair on the opposite side. The steam valves are V-shaped and partly balanced, the valve seats being separate and bolted to the cylinders. In Fig. 3 the steam valve is shown at *a a* and *b b* indicates the seat over which the valve rides, permitting the steam to pass from the chest through the valve and seat into the cylinder. The exhaust valves are shown at *c c*, Fig. 3, and the seat at *d* with a plate *e e* to hold the valve against the seat.

A study of Fig. 4 will give an idea of the arrangement of the valves in the cylinder. In the plan one end of the cylinder is in cross-section, showing the steam and exhaust valves for that end in their relative positions. The elevation shows the steam valve-chest with the valve in position, the small letters having the same significance as in Fig. 3. In Fig. 4 it will be seen that *A* is the steam passage to the valves and *B* the exhaust passage away from the cylinder, but to understand more fully the arrangement of the mechanism for driving the valves, reference should be made to Fig. 5, in which *A* is the elevation of the steam wrist-plate and *B* a plan view. At *F* the wrist-plate is in its central position, with the cranks *H, H* and the yokes *I, I* in the same relative positions. On one end the yoke is shown in section and the manner in which the steel slide *a* engages the steel toe *b* in the yoke is also indicated.

When the wrist-plate is in the position indicated in Fig. 5, the other valve-rod pins are in the positions shown, and when the wrist-pin is at *c* at one extreme of its throw, the other valve-rod pins are at c^1, c^2, c^3 and c^4, respectively. By the time the wrist-pin has reached its other extreme of travel at *d*, the other pins are at d^1, d^2, d^3 and d^4. In the plan *B*, Fig. 5, is shown the rock-shafts *e e* with the steam valve-crank *H* in place on only one of the shafts. The splined spindles *f f* pass through the hollow rock-shafts and valve-cranks as shown, and on one end is a nut *g* which can be adjusted to lengthen or shorten the spindles. At *h* is shown the key which is set diagonally across the end of the spindle and engages a key-way in the plate *A*. A sectional elevation through the same spindle and shaft is shown at *C*, and at *I* is a bracket which helps support the rock-shaft *k*.

Fig. 6 illustrates the exhaust wrist-plate *F'*, which is on the the same shaft, only at the end opposite to that occupied by the steam wrist-plate. It will be noted that the valve-rod pins in the wrist-plate are set above the center of the plate, while those in the steam wrist-plate are on the same line when set central. As seen in Fig. 6, the valve-crank *H'* is fastened to the valve-yoke *I'* by a pin in the sliding block *a*.

Both the steam and exhaust valves are lapped when they are down at the lower end of their travel, with the plunger in the dash-pot seated. When traveling up the valves open, and close in coming down, but to get a complete understanding of the movement of each valve, reference should be made to Figs. 7, 8, 9 and 10, in all of which the same reference letters hold good as to lines and different parts. For the sake of greater convenience the valve is shown from one side, but this must not be mistaken for the true relative position of the valve to the valve-gear. One steam valve is shown only, and for the purpose of illustration the steam valve on the crank end of the cylinder will be considered.

In Fig. 5 the wrist-plate *F*, valve-crank *H*, yoke *I* and valve *a* are in the position

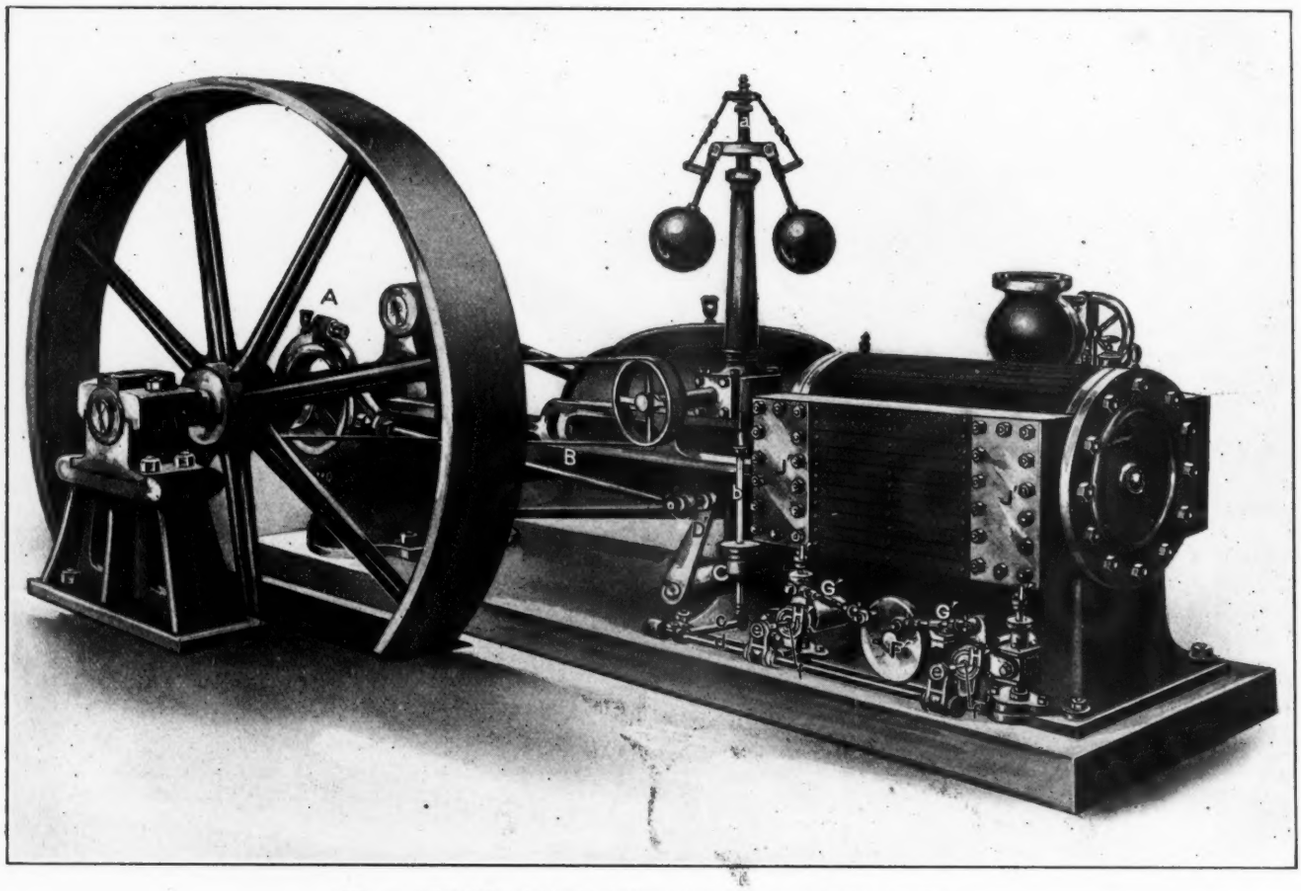


FIG. 2. EXHAUST SIDE OF WRIGHT AUTOMATIC CUT-OFF ENGINE

at which the valve is lapped, and the wrist-plate and eccentric are on the center of their travels. The center line *A A* is horizontal through the wrist-plate and valve-crank rockers, *B B* representing the center of the wrist-plate and *C C* the center line of the valve-crank shaft. The dotted line *D D* shows the arc in which the end of the plate *d* travels when the valve admits steam during the full stroke, and to the right of Fig. 7 is the eccentric circle in which $X X^1$, X^2 and X^3 are separate eccentric positions, and *C* and *C'* are two separate positions for the crank. The arrows denote the directions of travel of each part at this central position of the eccentric and wrist-plate.

Bearing in mind that the wrist-plate on the opposite side is operating the exhaust valve, it will be noted that when the steam wrist-plate and valve-crank are in the position shown, connected by the rod along the line *G*, the wrist-plate pin and valve-crank pins for the exhaust on the opposite end are at *c c* connected along the dotted line *G'*. When the wrist-plate and valve-crank are in the position shown, with the valve lapped and the crank at its center *C* on the eccentric circle, the eccentric will be at *X*. Since the valve opens while traveling up, all the parts must move in the direction denoted by the arrows. To overcome the lap, the eccentric would be moved up to X^1, and then to give lead the eccentric must be still further advanced to X^2, with the crank still at *C*. This gives the angle at which the eccentric should follow the crank, and if continued together in their travel to the point of cut-off, with the plate *d* at its maximum cut-off position, the crank and eccentric would be at C^2 and X^3, respectively, or the crank would have reached 90 per cent. of its stroke.

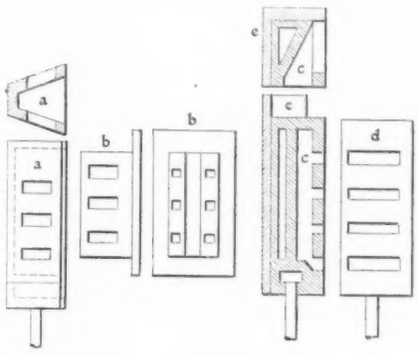


FIG. 3

It will be noted that the movement of the eccentric is enough to give a travel twice the width of the port and lap of the valve, but that the valves themselves travel only far enough to overcome the lap and port opening. The full lines show the valve port and the dotted lines the position of the port in the valve seat. The dotted lines to the side give the relative positions of the valve and port in port opening and lap, and the dotted lines to the side of the valve-yoke *I* show the positions to which the plate *d* must lift the yoke to overcome lap and give full opening. The sum of the two is the valve travel.

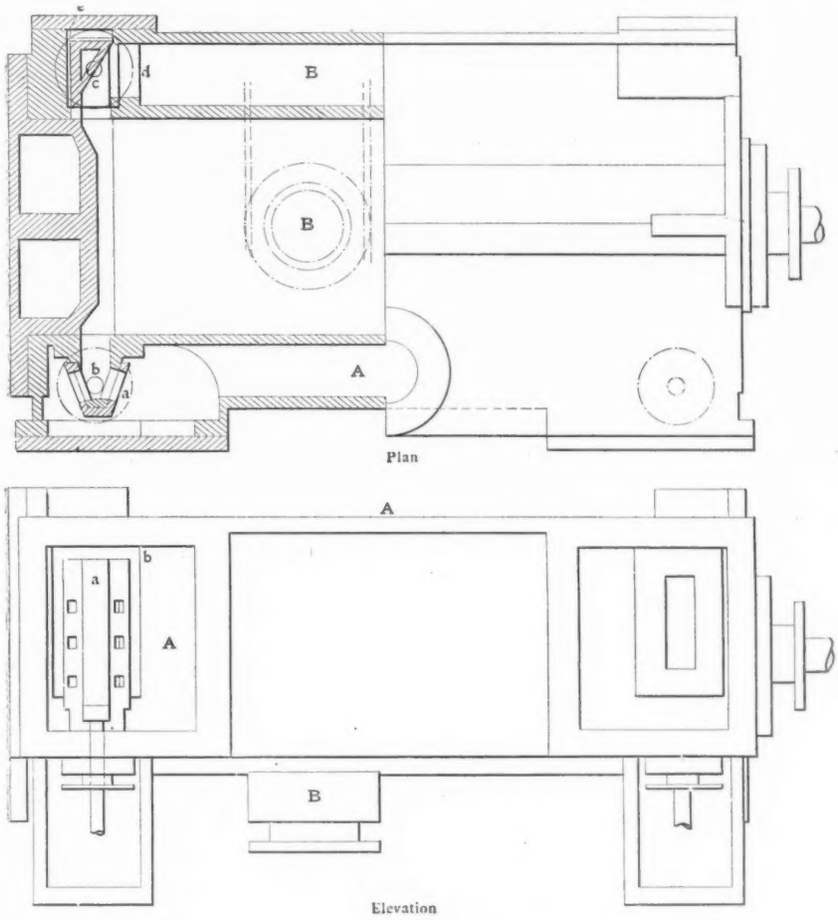


FIG. 4

Bearing in mind that the eccentric is at *X*, with the wrist-plate, valve-crank and valve in the positions shown, we may advance one step in the movement. In Fig. 8 the position of the wrist-plate, valve-crank and valve are shown when the eccentric is advanced to the point *X* on the travel to give lead to the valve with the crank on its center *C*. The crank and eccentric will now travel together. The relative positions of the exhaust pins are shown at *c c*.

Fig. 9 shows the valve fully opened, having reached the full hight of its travel. The eccentric and wrist-plate are also at the extremes of their travels, and as the plate *d* is so far extended under the valve-yoke that it will not disengage, the valve will not close until the crank and eccentric have so far advanced in their travels as to allow the valve to be lowered far enough to effect cut-off, which is shown in Fig. 10. In this figure it will be noted that the direction of travel in the wrist-plate, valve-crank and valve have been changed, and cut-off has been accomplished.

As shown in Fig. 5, the governor acts on the steam valves and effects an early or late cut-off through the medium of a splined rod running through the valve crank-shafts; when the rod is drawn through the hollow valve-crank, it either causes the plate not to pick up the valve yoke at all, or allows it to carry full stroke. A study of Figs. 11, 12 and 13 will fully explain this action. In these figures *A A* is the center line of plate *d* and valve-yoke *I*. The end of the rod is shown at *S*. The bottom drawings are plans and those at the top are elevation views.

In Fig. 11 it will be noted that the splined end of the rod is extended through as far as it will go, thus making the plate *d* extend through the valve-yoke to its position for maximum throw. In the elevation the line *D D* shows the arc through which the end of this plate will travel while operating the valves. When the conditions are as shown in Fig. 11, the governor should be at rest or at its lowest point of operation. The rod *S* will then be ready to travel in the direction of the arrow when the governor takes hold. When the valve-gear is in the position shown in Figs. 7, 8, 9 and 10 the rod *S* and plate *d* are as shown in Fig. 11.

With conditions as in Fig. 11, the valve is given its full maximum travel, but from that point, as the governor begins to pull the rod *S* in the direction of the arrows, the plate *d* travels in the arc of circles which grow smaller and smaller

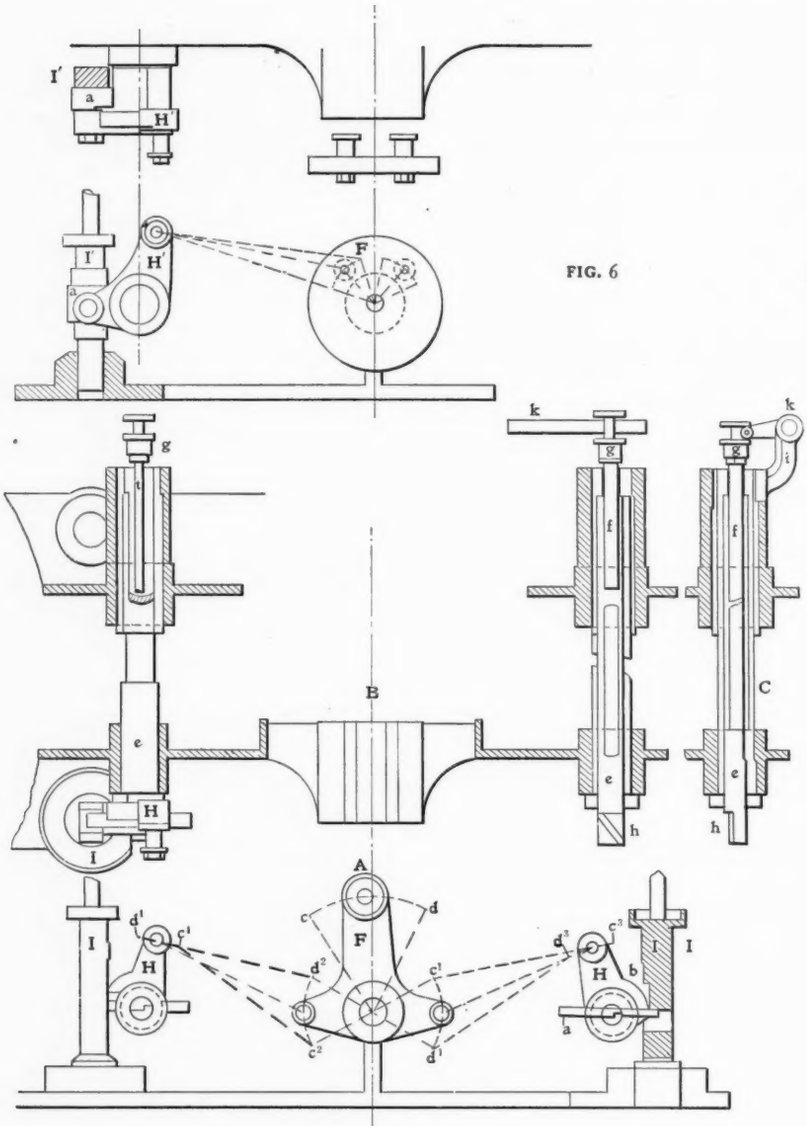


FIG. 5

FIG. 6

until the position shown in Fig. 12 is reached. Here it is shown that the rod *S* has been drawn out to half the distance of the length of the splined end, and as a consequence the plate *d* has been drawn back until the arc *D D* through which that end travels has grown smaller and does not lift the valve so far. The difference in the distance to which the plate now raises the valve, and the distance required for full port opening is shown at *f* and *g*, the latter reference letter in this case equaling the full valve travel. The eccentric, always moving the same amount, throws the plate *d* along the line *D D* enough farther to allow it to disengage itself from the yoke *I*, and the latter in dropping causes the valve to cut off. This event occurs when the piston has traveled about one-fifth of its stroke, with the rod and plate in the positions shown in Fig. 12.

When the governor weights have reached their maximum position and the engine its its normal speed, the splined rod is drawn out still farther until the plate *d*, Fig. 13, will not engage or pick up the valve at all. At this point, when no steam is admitted to the cylinder the minimum valve travel has been reached.

Setting the Valves

These engines were made and put in operation before many of the niceties of engine design were thought of. For instance it will be noted that the valve stems set down in the valve yokes on a shoulder and are secured in place by a set-screw. This does not allow of easy adjustment of the length of the valve-stem or valve lap, and owing to the fact that the valve-stems are not easily adjustable, more care must be taken in each step toward setting the valves.

First, place the wrist-plate in its central position, as shown in Figs. 5 or 7, and note that the hook pin at the top of the steam wrist-plate is not on the vertical center line of the plate, but is off center a few degrees in the direction of the cylinder-head or away from the engine shaft. The two steam valve-rod pins on the wrist-plate are on the same center line as the wrist-plate center, and when these pins are level and on an exact line with the wrist-plate and valve-crank centers, the wrist-plate is on the center of its travel. It is a good plan to clamp the wrist-plate into central position, while doing the first part of the valve setting, by slacking off on the washer on the end of the stud, placing paper underneath and clamping down on that. If the wrist-plate is keyed on the shaft, it can be held in place with a thin wedge driven between the boss of the wrist-plate and the cap of the bearing next to it.

Then adjust the length of the valve-rods so that the plate *d* in the valve-crank *H* is horizontal, as in Fig. 7. If there is no adjustment in the length of the valve-rods, then note whether or not the valve-cranks are in the required position when the wrist-plate is central. In all probability they will be, but, if not, the valve-rods must be changed to the proper length even if they have to be taken to a machine shop for the purpose. With the governor in its lowest position, adjust the length

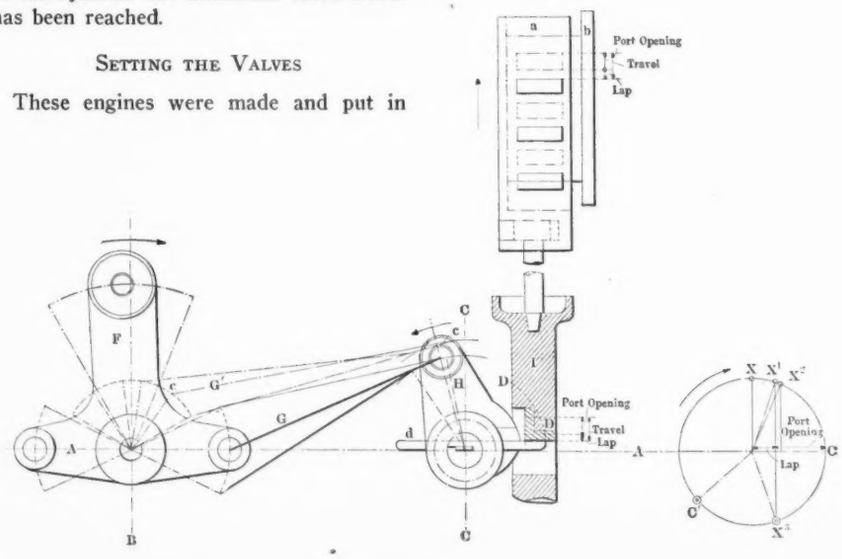


FIG. 7

of the rod *S* so that it is at its outer extreme position, as in Fig. 11, with the plate *d* as shown here and in Figs. 7, 8, 9 and 10. Now hook up the eccentric-rod to the wrist-plate and free the latter so that it will work and roll the eccentric slowly around the shaft in the direction it is to run. Carefully note the length

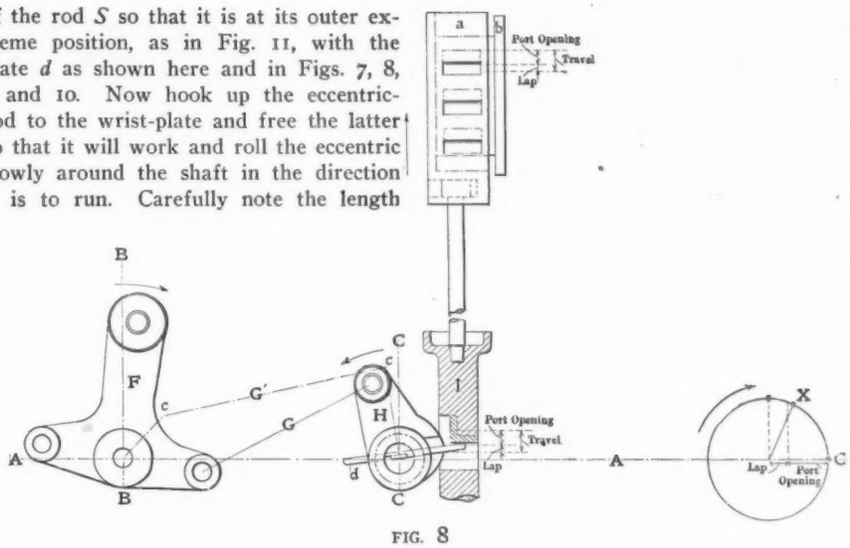


FIG. 8

of travel of each of the valves and see that when they are at the top extreme of their travel that the ports are open no more than in Fig. 9. If both the valves have the same travel and should pass over the edge of the port or farther than necessary to give a full port opening, the plate *d* may be extended too far, and as a remedy the rod *S* should be shortened so that the valve can be raised just far enough to give the full port opening. If the two valves travel unevenly, they must be adjusted to travel alike, and separate adjustment can, of course, be made to each. If the valves do not travel far enough to give a full port opening with the adjustment of plate *d* as in Fig. 11, then something must be done to lengthen the valve-stems.

After the steam valves have been adjusted the next thing to do is to set the exhaust valves so that they will travel just far enough to give a full port opening. When turning the eccentric around with the wrist-plate hooked up, a mark can be placed on the wrist-plate and another mark opposite it, at each extreme of the travel, on the hub, adjacent bearing cap or washer, as the case may be. With dividers, the distance between these points can be bisected and a mark made to center the wrist-plate. If, when the mark on the wrist-plate is brought to this center mark, it does not appear central, as in Fig. 7, then the length of the eccentric-rod is wrong and must be proven. The best way to do this would be to make a new set of marks, first placing the wrist-plate central, as in Fig. 7. Then make a central mark on both wrist-plate and adjacent cap and lay out the two extreme points as follows:

In Fig. 14 let *A B* be the distance from the center of the wrist-plate hub to the center of the hook-pin, *A C* the distance from the wrist-plate hub center to the surface of the hub or washer where the marks are to be, *D E* the travel of the hook-pin and *F G* the distance apart the extreme positions are to be.

For example, let *A B* = 10 inches, *A C* = 3 inches, *D E* = 5 inches and *F G* = ?. Then

$$10 : 3 : : 5 : ?$$

$$(3 \times 5) \div 10 = 1.5$$

inches. In this case the distance between the extreme points would be 1½ inches, and taking a pair of dividers and setting them at ¾ inch, a mark could be scribed

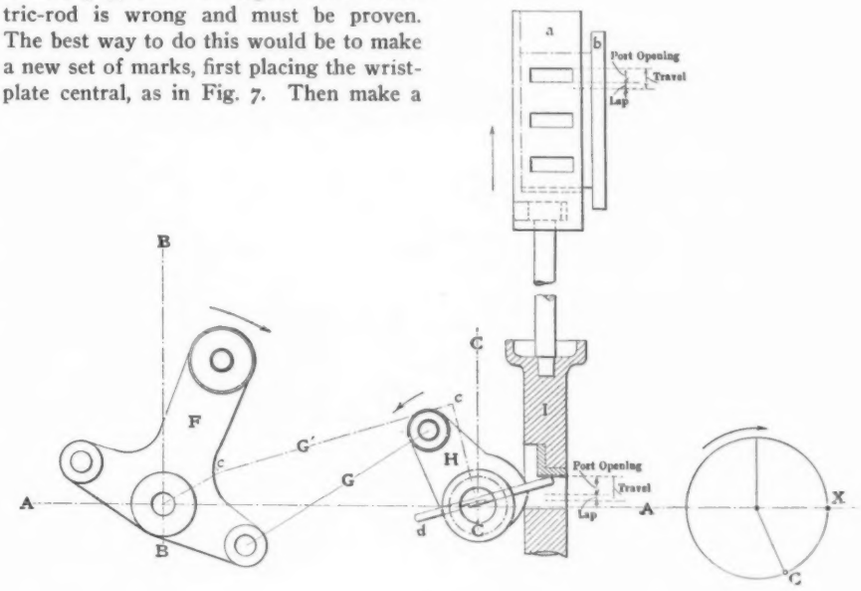


FIG. 9

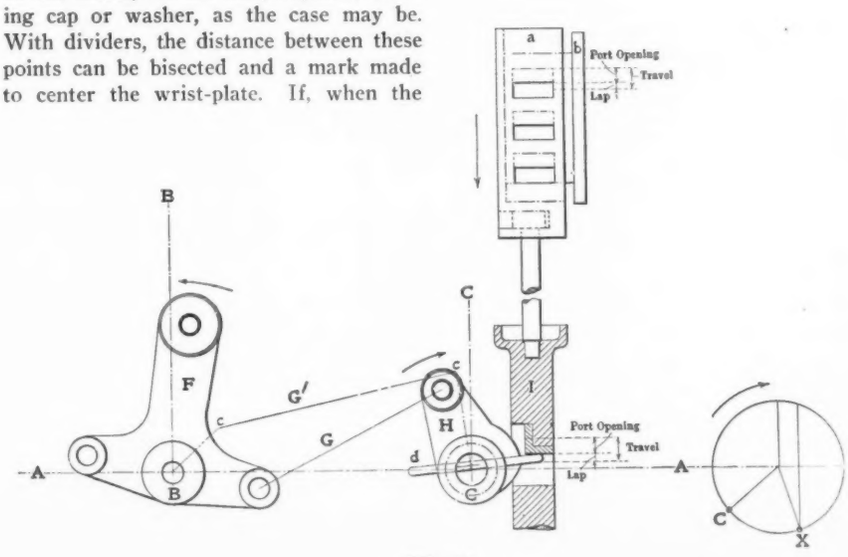


FIG. 10

on each side of the center line with which the center line on the hub should coincide at each extreme of the travel. Turn the eccentric around again and if the center mark on the hub comes short of one mark and over the other, one of the rods is too long or too short between the eccentric and the wrist-plate.

Note whether or not the rocker-arm travels equally on each side of the center line, which should be exactly vertical when the eccentric is at half stroke. If the rocker-arm does not travel equally on each side of the center line, as for illustration from *D* to *B* and *B* to *E* in Fig. 14, the eccentric-rod is too long or too short and must be adjusted. If the travel of the rocker-arm is correct and still the wrist-plate does not travel equally to its extreme positions, the hook-rod needs adjustment.

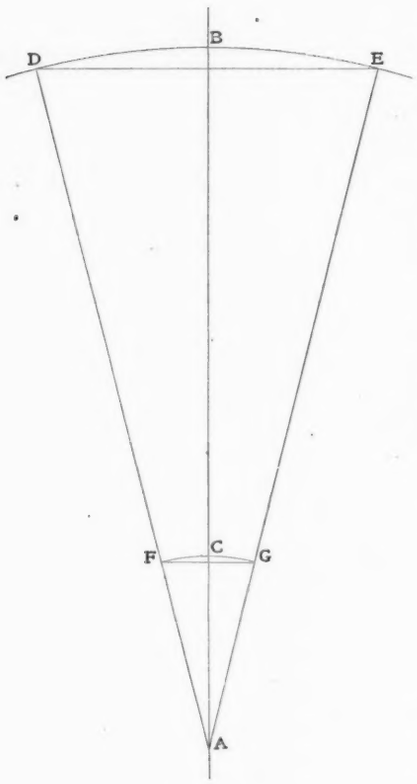


FIG. 14

Having equalized the travel of the wrist-plate and valves, proceed to set the valves for running. Place the engine on one center and pull the eccentric around until there is lead on the steam valve for that end, and then make the eccentric fast to the shaft. Next pull the engine around and observe that the exhaust valves release at from 90 to 95 per cent. of the stroke and that the steam valves cut off at from 80 to 90 per cent. of the stroke for the maximum. The exhaust valves should close for compression at from 95 to 97 per cent. of the stroke. Make the lead of the steam valves nearly equal with a trifle more on the crank end.

After the valves are set, block up the governor to its highest point, and while pulling the engine around one complete revolution, see that the steam valves do not pick up at all. To reverse the engine, reverse the eccentric. If, when the indicator is applied, it is found that earlier valve action is desired, it is best to set the eccentric ahead, or back if later action is desired. To get an earlier steam cut-off, the change can be made on the rod *S*, Figs. 11, 12 and 13, but if earlier cut-off is secured in this way, there will be less lead. To obtain a later cut-off in this way will give more lead.

Catechism of Electricity

715. Can two series-wound dynamos be operated satisfactorily on the same circuit?

They can, but they are connected in series instead of in parallel. Fig. 239 shows two series dynamos *a* and *b* thus connected across the bus-bars *h* and *m*. The positive terminal of *a* is connected to the negative terminal of *b*, the positive terminal of *b* is connected to the bus-bar *h*, and the negative terminal of *a* is connected to the bus-bar *m*. The helix *c* represents the series field winding of *a*, and *d* the series field winding of *b*.

To make each machine do its share of work, that is, generate the same voltage, it is necessary to provide means for regulating the current in the field windings, *c* and *d*. To accomplish this, rheostats *i* and *j* are connected in shunt to the field windings, and by means of these the current in the windings is regulated. By moving the arm of the rheostat *i*, for example, so that some of the shunt resistance is cut out, the current through the shunt will be increased, that in the field winding *c* will be decreased, and the voltage of the dynamo *a* will, consequently, be diminished. The voltage of the dynamo *b* may be similarly regulated by the rheostat *j* in shunt to the field winding *d*.

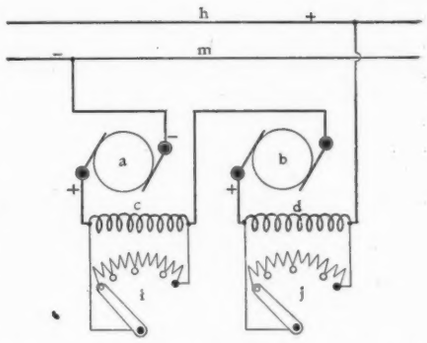


FIG. 239. DIAGRAM OF TWO SERIES-WOUND DYNAMOS CONNECTED IN SERIES

716. Can series-wound dynamos be operated satisfactorily in multiple?

They will not operate in multiple if connected up like shunt machines in multiple, for a drop in the voltage of one dynamo will cause that machine to drop a part of its load, and this, in turn, will diminish the strength of its field and cause the load to drop off still more. As the load drops off, the voltage decreases and soon reaches a point where the other machine will overpower this one and operate it as a motor; this condition would be injurious

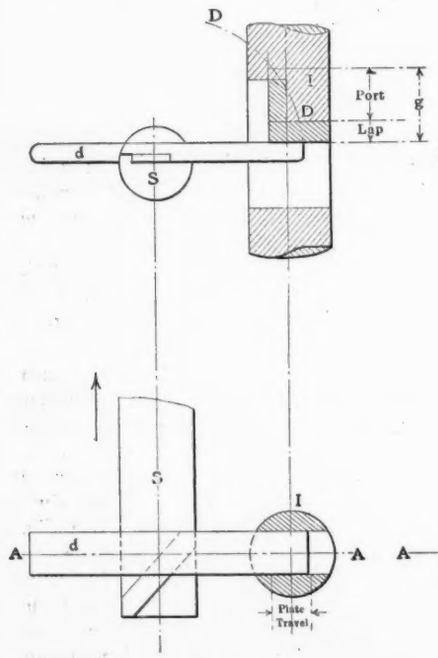


FIG. 11

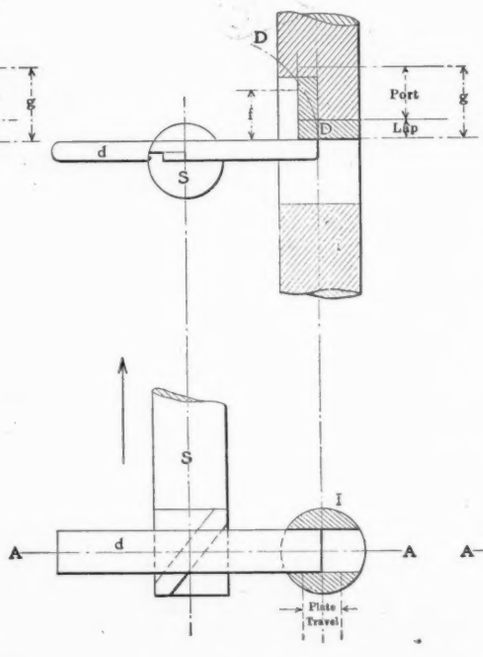


FIG. 12

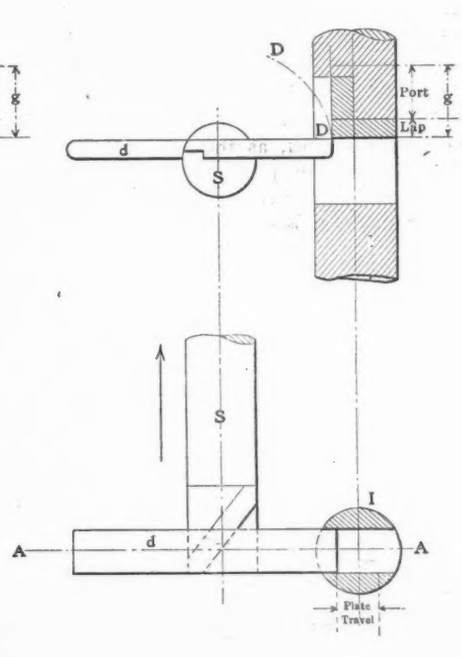


FIG. 13

to both dynamos. This difficulty may be overcome by keeping the voltage always the same across the field-winding terminals of both machines. In order to do this, the field windings of the machines

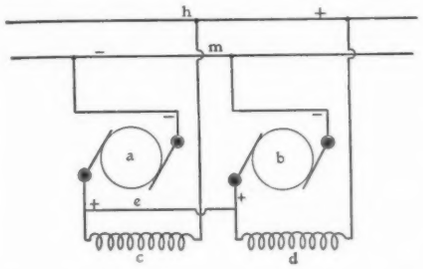


FIG. 240. DIAGRAM OF TWO SERIES-WOUND DYNAMOS CONNECTED IN MULTIPLE

are connected in multiple, as shown in Fig. 240. Here *c* and *d* are the field windings of the dynamos *a* and *b*, respectively, as before. One end of each of the

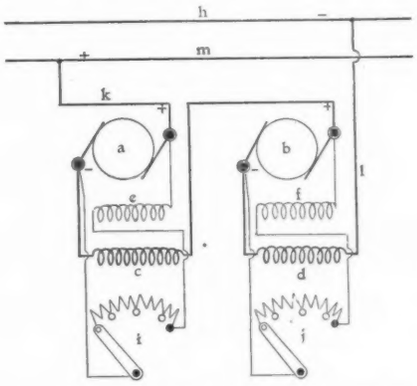


FIG. 241. DIAGRAMS OF TWO COMPOUND-WOUND DYNAMOS AS CONNECTED IN SERIES; SEPARATE FIELD CONTROL

field windings is connected directly to the bus-bar *h*, and the other ends are connected to a heavy wire *e*. This connection causes the difference of potential between

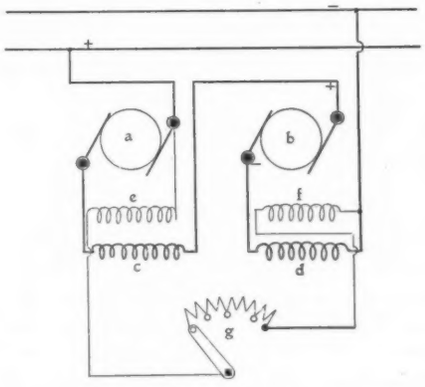


FIG. 242. DIAGRAM OF TWO COMPOUND-WOUND DYNAMOS CONNECTED IN SERIES; COMMON FIELD CONTROL

the two ends of both field windings to be the same, so that the current is equally divided between the two windings. Each machine will, therefore, have the same field strength and generate the same pressure, and if for any reason one machine becomes weakened, the stronger one will build up the weaker one. Since the wire *e* serves to equalize the pressure across the two field windings, this wire is called an "equalizer."

717. *Can compound-wound dynamos be operated in series satisfactorily?*

They can. Fig. 241 shows two compound dynamos *a* and *b* connected in series across the mains *h* and *l*. The shunt field windings *e* and *f* of the two machines are controlled by the rheostats *i* and *j*. When two compound-wound dynamos are operated in series regularly it is advisable to have the two machines of the same size and type so that their voltages will always be equal. The two shunt windings *e* and *f*, may then be connected in series with each other and with a controlling rheostat *g*, as illustrated in Fig. 242. This method insures equal field excitation and, consequently, proper division of the load.

A Puzzling Case of Back-firing

By E. L. Hill

The engine referred to herein is a two-cylinder tandem double-acting gas engine, direct-connected to a 500-kilowatt 250-volt direct-current generator, and supplied with gas from suction producers using a good grade of bituminous coal which averages about 14,000 B.t.u. per pound. The engine cylinders are 32 inches bore and 42 inches stroke. At the time of the trouble, the engine had been running a few weeks and was still in the hands of the builder's erector, and as he intended to leave in three or four days, he put on the indicators with the intention of taking cards and assuring himself that everything was in proper condition and good running order. The first day the instruments were used the engine ran splendidly, the cards looked good and apparently there was nothing to be desired. On the second day, in the morning, there was a little back-firing, which increased to a considerable extent as the day went on, and for which no plausible cause could be found.

When the back-firing began to get worse, the erector immediately complained that the gas was too rich, but not much credence was given to that explanation by anyone but himself, for reasons noted further on. However, as he still had charge of the engine and as he insisted that this was the cause of the trouble, the short "runs" of water gas were cut down 30 per cent., and they were short enough already—in fact, too short before the change was made. In spite of the leaner gas the engine now received, the back-firing grew steadily worse, and was not confined to either cylinder, which added a little more mystery to the case.

The third morning brought no change except that the back-firing had become very nearly intolerable. The erector now claimed that the gas was still too rich, and to satisfy him it was necessary to discontinue making water gas entirely. This did not bring the required relief, and the erector stoutly maintained that even under the then existing conditions the gas was still too rich for the engine.

The engine was so seriously affected by this time that it would not carry its normal load, but would promptly "lay down" every time the load went above 1800 amperes, and it was necessary to keep a 500-kilowatt steam unit turning over continually, and to put it into service every little while, when the gas engine had a bad spell of back-firing, in order to keep the circuit-breakers from coming out. (The gas-engine unit was running in parallel with still another steam-driven unit.) In the opinion of the writer the trouble was not due to "rich gas," but to make certain of it a Junker calorimeter was set up in the engine room and the heat value of the gas was tested. The calorimeter showed that the gas was not rich, the heat value varying from 90 to 100 B.t.u. per cubic foot. To make assurance doubly sure, samples of the gas taken in the engine room were analyzed, and in no case was the hydrogen above 3 per cent. Furthermore, the writer had coöperated with the engineers of the engine builders on an exhaustive test of a similar engine of somewhat smaller size, during which the best results were obtained with a gas showing 8 to 9 per cent. of hydrogen and containing 110 B.t.u., the other constituents being practically the same as the gas in question. Clearly the trouble was not with the gas.

The ignition timing was changed time and again; the mixture was varied, the igniters gone over, and still the back-firing continued. Finally, the engine was shut down, the indicators and their cocks taken off, and the plugs which belonged in the indicator nipples leading through the water jacket to the cylinder were put in place; these plugs were approximately 8 inches long. Again the engine was started, and not a back-fire could be heard, even with full load, although the engine was sluggish as the load increased, due to the poor gas. Here, then, was the trouble which had taken the better part of three days to find; all the back-firing was caused by the burned gases trapped in the indicator passages, which remained sufficiently hot to ignite the incoming mixture during the suction strokes.

The water-gas runs were promptly renewed, and even lengthened over what they were before the trouble started, and the heat value of the gas increased to 110 B.t.u., where it should be, with the gratifying result that the engine did not give further trouble, and "rich gas" was a thing of the past.

Proper Thickness of a Valve Deck in a Pump

By William F. Fischer

Referring to an article appearing on page 610 of the April 21 number, on the method of calculating the proper thickness of a valve deck in a pump, the writer wishes to offer herewith other solutions to the problem.

The valve deck in question is 48 inches in diameter, and the pressure on the deck is 105 pounds per square inch of surface. The plate is perforated with circular valve openings, therefore we must depend upon the ribs only to support the load on the deck. Mr. Nickel assumes six radial ribs, 1½ inches wide.

Taking the ultimate strength of cast iron in flexure (as in a beam subjected to both tensile and compressive stresses) as 30,000 pounds per square inch, and using a factor of safety of 10 for varying loads:

$$f = 30{,}000 \div 10 = 3000$$

pounds per square inch. Then,

$$t = \sqrt{\frac{2\,r^2\,p}{3\,f}},$$

or

$$t = \sqrt{\frac{2 \times 24^2 \times 105}{3 \times 3000}} = 3.67 = 3\tfrac{5}{8}$$

inches thick.

By adding six ribs to the deck, we divide it up into six equal sectors of 60 degrees each (see Fig. 1). Then, in order

n = Number of sectors.

As t^2 was found to be 13.44 inches, then

$$Z = \frac{b\,t^2}{6} = \frac{25.13 \times 13.44}{6} = 56.3.$$

Therefore, each rib to be of equal strength should have a section modulus of 56.3.

If we assume B as 2 inches (see Fig. 2, which is an end section of a sector and rib), B = width of rib and d = depth of rib. Then,

$$56.3 = \frac{B\,d^2}{6},$$

or

$$d = \sqrt{\frac{6 \times 56.3}{B}} = \sqrt{\frac{6 \times 56.3}{2}} = 13$$

inches. Therefore, six ribs, 2x13 inches,

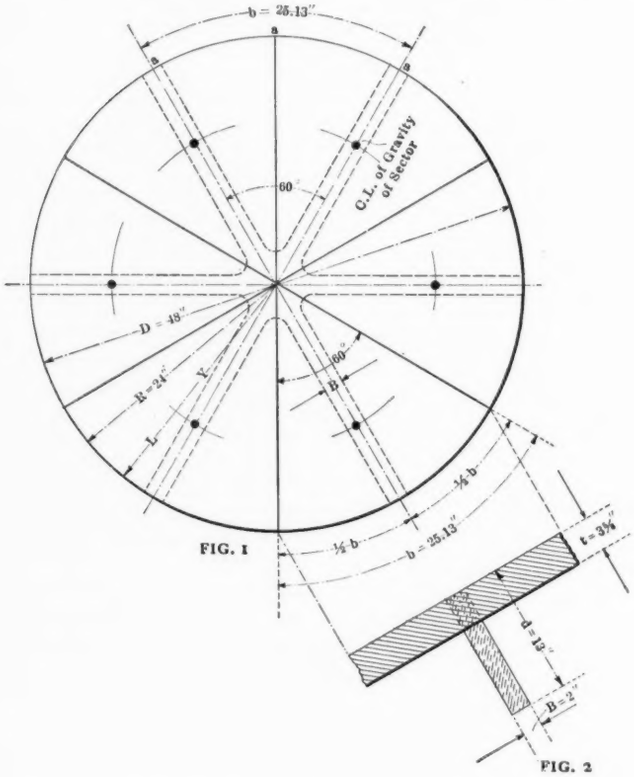


FIG. 1

FIG. 2

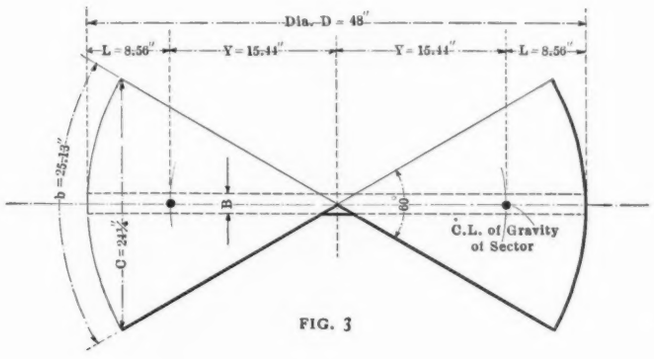


FIG. 3

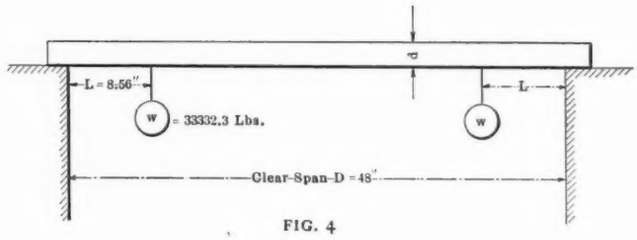


FIG. 4

If we consider the deck as a flat, cast-iron circular plate fixed all around the edge, according to Grashof (see "Kent's Pocketbook," page 283),

$$t = \sqrt{\frac{2\,r^2\,p}{3\,f}},$$

where

t = Thickness of plate, or deck, in inches,

r = Radius of plate, or deck, in inches,

p = Uniformly distributed pressure on deck (pounds per square inch),

f = Safe allowable working stress in pounds per square inch on material composing plate.

r = 24 inches and p = 150 pounds.

to be of sufficient strength each rib should have a section modulus equal to, or greater than, the section modulus of a sector at the supported edge $a\,a\,a$, which can be found as follows:

$$Z = \frac{b\,t^2}{6},$$

where

Z = Section modulus of one sector at the supported edge,

b = Breadth of section,

t = Depth of section.

$$b = \frac{D\,\pi}{n} = \frac{48 \times 3.1416}{6} = 25.13$$

inches, where

D = Diameter of deck,

π = 3.1416,

are required to support the load on the deck.

Still Another Method

Another method would be to consider two opposite ribs as a rectangular beam with a clear span D of 48 inches between the supports, each beam supporting two sectors and their share of the load (see Fig. 3).

Consider the uniform load on each sector as acting at its center of gravity, which is found as follows:

$$Y = \frac{2\,r\,c}{3\,b} = \frac{D\,c}{3\,b},$$ *

where

*See "Kent," page 419, "Center of Gravity of a Sector of a Circle."

D = Diameter of circle = 48 inches,
c = Chord of arc (measured on scale drawing as 24¼ inches),
b = Length of arc = $D\,\pi \div 6 = 48 \times 3.1416 \div 6 = 25.134$ inches.

Then,

$$Y = \frac{D\,c}{3\,b} = \frac{48 \times 24.25}{3 \times 25.134} = 15.44$$

inches, and

$$L = R - Y = 24 - 15.44 = 8.56$$

inches. The total uniformly distributed load on the deck is

$$W = A\,P = D^2 \times 0.7854 \times P = 48^2 \times 0.7854 \times 105 = 190{,}003.8$$

pounds, and the uniform load on each sector becomes

$$w = W \div n = 190{,}003.8 \div 6 = 31{,}667.3$$

pounds, acting at the center of gravity of each sector, where

A = Area of deck in square inches,
P = Pressure in pounds per square inch,
D = Diameter of deck,
n = Number of sectors.

This is simply a case of a rectangular beam supported at both ends with two symmetrical loads (see Fig. 4).

The maximum bending moment is designated as $M = w\,L$, and the resisting moment for rectangular beams $M_1 = f\,\frac{B\,d^2}{6}$, where f = safe allowable stress in extreme fiber in pounds per square inch and $\frac{B\,d^2}{6}$ = the section modulus of the beam. The bending moment should equal the resisting moment, or $M = M_1$, or $w\,L = \frac{f\,B\,d^2}{6}$, and $d^2 = \frac{6\,w\,L}{B\,f}$ and

$$d = \sqrt{\frac{6\,w\,L}{B\,f}}.$$

If we assume B to be 2 inches, as before, and, as found, w = 31,667.3 pounds, L = 8.56 inches and f = 3000 pounds, then

$$d = \sqrt{\frac{6\,w\,L}{B\,f}}$$

$$= \sqrt{\frac{6 \times 31667.3 \times 8.56}{2 \times 3000}} = \sqrt{271.072}$$

$$= 16.46 = 16\tfrac{7}{16}$$

inches. Therefore, according to this method, which seems more accurate than the other, if the deck itself is assumed to play no part in supporting the load, there should be six ribs 2 inches wide by $16\frac{7}{16}$ inches deep. These appear to be pretty "husky" ribs, and may be out of the question as far as the rest of the design goes; but when we consider a total load on the deck of 190,004 pounds, that looks pretty "husky" also.

It seems to the writer that if the ribs are made sufficiently strong to carry the whole load, it is quite unnecessary to make the deck 3⅝ inches thick; 2½ inches should be quite sufficient.

Location of Strainers

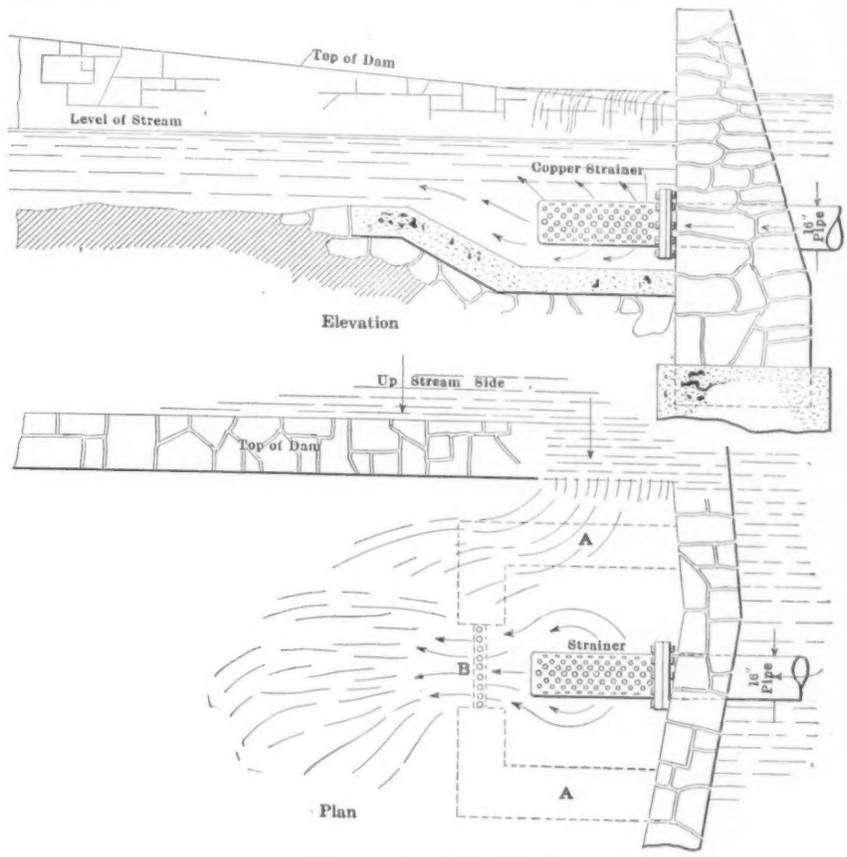
By W. E. Crane

In taking water from a stream there is often difficulty with the strainer. Either it is clogged up or it lets through a lot of debris of various kinds. After a lot of trouble the writer learned that if the strainer was put in a strong, clean current, everything tending to clog it would be washed away. Of course, there are cases where this cannot be done, and recourse must be had to double strainers that have to be cleaned.

One of the types of strainer that gives little trouble is shown in the illustration. In this case, just below a small, cheap dam, a place is scooped out for the strainer and the bottom paved so as not to be washed deeper. The dam across the stream was at about the level of the bed of the river and gradually rose toward the opposite bank so as to throw the larger part of the stream over the strainer. The pipe is 16 inches in diameter and the strainer is of copper with punched holes, the area of the holes being about eight times the area of the pipe. After the strainer had been in for five years, the writer asked the superintendent if the strainer ever troubled them, and he asked: "What strainer?" He was not aware that there was such a thing as a strainer in the stream.

Later I was doing some work at the factory and learned that they were having lots of trouble with their water supply. Investigation showed that their fire-insurance company had ordered them to build a structure, $A\,A$, with a rack of round, iron rods. This catch-basin became filled with sand, leaves and the like, except right around the strainer where it was necessary to keep it clear. It will be noticed that when the strainer is brushed off, the material cannot get outside. Whenever sand or debris of any kind came down the river, quantities of it were brought into the catch-basin, and everything that could pass the strainer passed on and filled up pipe and well, while that portion too large to pass stayed on the outside and plugged it up.

If a scheme had been specially devised to make trouble with the water supply, a better arrangement than the catch-basin could not have been found. Fortunately, in case of fire, the company had a good supply from the city pipes.



STRAINER IN POSITION BELOW DAM

If you wish to hear the internal noises of an engine more distinctly, place your ear against the cylinder lagging. If this is too hot for comfort, place a small board between.

Design of Corliss Engine Crossheads

The Essential Features of Construction of Different Types Described and Illustrated, with Practical Comments upon the Merits of Each

BY L. L. WILLARD

Fig. 1 shows three views of a type of crosshead which, with slight modifications, is used by many engine builders. Referring to the side elevation, it will be seen that two patterns will be required, one for the body and one for the shoe. The material used is generally cast iron, the surface of the shoes being lined with babbitt. For large engines, steel castings are often specified and it is becoming general practice for builders to use steel even if not required by the purchaser. At times an engineer will be met who insists on the shoes being made of brass, the surface being cored out to receive babbitt at a sufficient number of spots to obtain a large enough bearing surface. In case any cutting is taking place, the brass will bear on the guides instead of the cast iron or steel as in the other type.

The bearing surface of the body on the shoe is usually tapered 2 inches in 12, so that by screwing up on the adjustment nuts a vertical movement is obtained to take up any wear that may occur. The pin is placed somewhat ahead of the center line of the shoe, so that when an adjustment is made the shoe moves forward, bringing the two centers in line after a time. A slot should be provided where the adjustment bolt passes through the shoe. The direction of motion is in the line of the length of the shoe, consequently the dovetails that are to hold in the babbitt should be run crosswise, so there will be no danger of the metal being pushed out.

In laying out the opening for the end of the connecting-rod care must be taken to have sufficient clearance in all positions of the rod as well as to have room to make any adjustments that will be necessary. The end is shown tapped out to receive the piston-rod, and the number of threads ordinarily used is given in a table of crosshead nuts. The threads are made with a fine pitch to give a stronger hold on the crosshead and so that less metal will be removed at the root of the thread and thereby make a stronger rod. This method of making the connection to the crosshead is much preferred on account of its flexibility, as it is not always possible, especially in tandem engines, to machine each part so that when they are assembled the length from the center of the shaft to the center of the cylinder will come exactly as figured upon. With a threaded connection this difference can be very easily taken care of, while with a keyed rod it will be seen that the length of all the parts must come exact to have the necessary clearance in the cylinder. When such construction is used, it is customary to set up the engine and take the necessary measurements to make the rod, or measure each part separately and figure the required length.

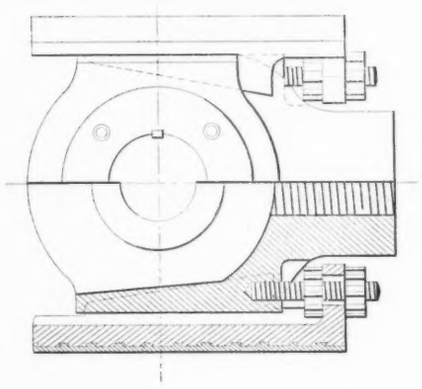


FIG. 1. COMMON TYPE OF CROSSHEAD

Two Adjustment Bolts Essential

In large crossheads two bolts for each shoe should be used for the adjustment, also a bolt on each side, clamping the shoe to the body after the adjustment has been made. The writer recalls a serious accident which wrecked an entire engine and was due to the use of only one adjustment bolt. The engine was driving a large generator already overloaded about 50 per cent., and when 10 per cent. more load was suddenly thrown upon it, a sharp snap was heard. Immediately the guide barrel was split open, releasing the cylinder and frame and throwing parts of the engine in all directions. The accident was attributed to the adjusting bolt break-

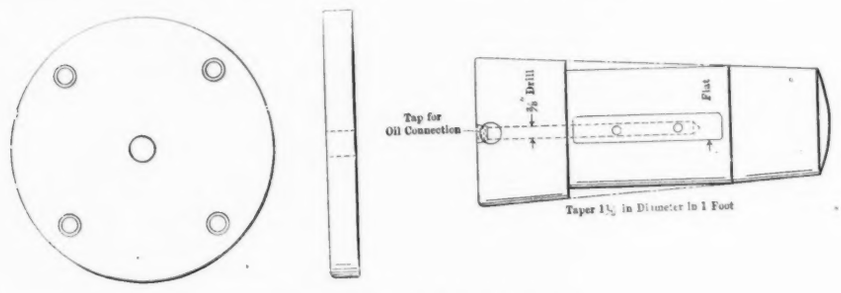


FIG. 2. CROSSHEAD PIN AND CAP

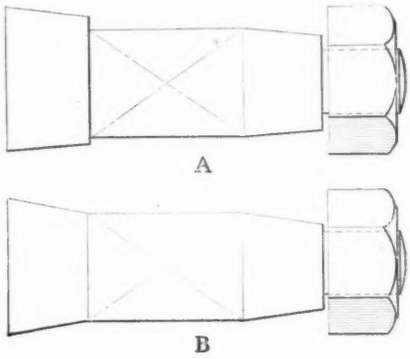


FIG. 3. TWO DESIGNS OF CROSSHEAD PIN

ing on the forward stroke of the engine, so that upon the return stroke the body of the crosshead was pushed upon the shoe with sufficient force to split the guide. A little figuring will show that it would not take a very great force to do this, the shoes acting as a wedge and the steam pressure and the energy stored in the wheel as the force.

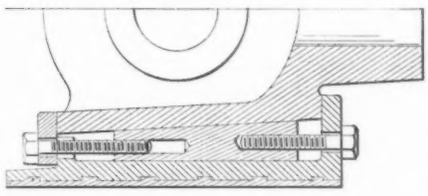


FIG. 4. CROSSHEAD WITH WEDGE ADJUSTMENT

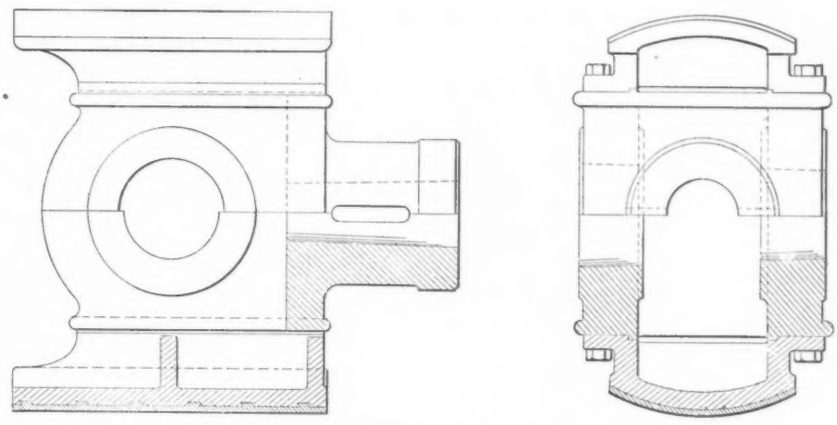


FIG. 5. CROSSHEAD WITH SHIM ADJUSTMENT

Pin *A*, in Fig. 3, shows a design preferred by some builders, but somewhat more expensive to machine. The nut is made large enough so that the flats will cover the hole in good shape, and when this is done it will be of a size proper to hold the pin. In Fig. 3, *B* is another design of pin in which the tapered part is not continuous. If it is desired to economize space on large work, this is a very good type to use. It will be seen that the plain end will be considerably smaller in diameter than the pin shown in Fig. 3, and, therefore, a smaller boss will be required on the crosshead.

It is sometimes specified that the type of adjustment shown in Fig. 4 be used. The wedge is operated by bolts at each end, giving a vertical adjustment without any lateral movement of the shoe. A larger diameter of the crosshead will be needed to get in the wedge, but the shoe can be made central with the pin. The section is taken through the wedge, showing the bearing surface which need not extend the full width, but as shown in the end view of the first type of crosshead.

In boring the hole for the pin a continuous taper of 1½ inches in diameter to the foot is allowed, as indicated in Fig. 2, which is the detail of the pin for this type for crosshead. A dowel is driven in the large end of the pin and fits in a corresponding recess in the crosshead to prevent the pin from turning. The top and bottom are flattened off about 1/16 inch to form a reservoir for the oil which is fed through the small holes from an outside connection, and the pin is held in place by the cap shown in the figure. Holes are provided for four bolts tapped into the crosshead. To determine the size of these bolts, consider the total steam pressure acting on the pin, which being tapered, will be pushed out of the hole if sufficient pressure is applied to overcome the friction. Considering the pin as a wedge and applying the usual formula, the total force caused by the steam pressure can be found, and from this the number and size of bolts necessary to withstand it. The friction is usually neglected and the allowable stress for the bolts increased somewhat.

DESIGN OF CORLISS ENGINE CROSSHEADS.

Diam. of Rod.	Threads per Inch.	A	B	C	D	E	F	G	H	I	J	K
2	6	4⅜	1½	2	3½	7/16	7/16	2¼	1	3	5/16	5/8
2¼	6	4⅜	1½	2	3½	1/8	1/8	2 1/16	1	3	1/8	5/8
2½	6	4⅜	1½	2	3½	1/16	1/8	2 1/16	1	3	1/8	5/8
2¾	6	5	1¾	2¼	4	7/16	7/16	2 1/16	1¼	3½	1/8	5/8
3	6	5⅜	2	2¼	4¼	½	½	3 1/16	1¼	3½	1/8	5/8
3¼	6	6⅛	2	3	5	½	½	3 1/16	1¼	4¼	1/8	5/8
3½	6	6½	2	3	5	½	½	3 1/16	1¼	4¼	1/8	5/8
3¾	6	6½	2	3	5	½	½	3 1/16	1¼	4¼	1/8	5/8
4	6	8½	2½	3½	6	½	½	4 1/16	1½	5¼	1/8	5/8
4¼	6	8½	2½	3½	6	½	½	4 1/16	1½	5¼	1/8	5/8
4½	6	8½	2½	3½	6	½	½	4 1/16	1½	5¼	1/8	5/8
4¾	6	9½	2½	3½	6	½	½	4 1/16	1½	5¼	1/8	5/8
5	6	9½	2½	3½	6	½	½	5 1/16	1½	5¼	1/8	5/8
5¼	6	9½	2½	3½	6	½	½	5 1/16	1½	5¼	1/8	5/8
5½	6	10½	3	4½	7½	1	1	5 1/16	1½	6	¼	1
5¾	6	10½	3	4½	7½	1	1	5 1/16	2	6¼	¼	1
6	4	10½	3	4½	7½	1	1	6⅛	2	6¼	¼	1
6¼	4	12	4	4½	8½	1¼	1¼	6⅛	2	6¼	¼	1
7	4	12	4	4½	8½	1¼	1¼	7⅛	2	6¼	¼	1
7½	4	14	4	6	10	1¼	1¼	7⅛	2½	8½	¼	1¼
8	4	16	4	6	10	1¼	1¼	8⅛	2½	8½	¼	1¼

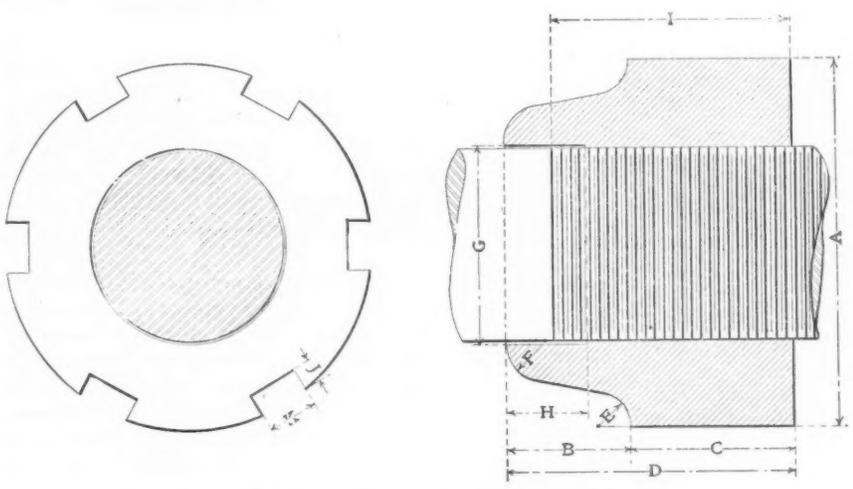


FIG. 6. COMMON TYPE OF CROSSHEAD NUT

Two views of a novel design of crosshead used by one firm of engine builders are shown in Fig. 5. There are some features here that are worthy of attention. The strains transmitted from the piston-rod are taken by the heavy metal around the pin which is well tied to the boss in which the piston-rod is keyed. The shoe, which is only intended to act as a guide and to take care of the vertical thrust, is made light. The pattern work is simple and the machining also much less than in the other types. The adjustment for wear is made by putting in liners or shims between the body and the shoe.

A common type of crosshead nut is shown in Fig. 6. It has two uses, and these are to act as a check-nut to keep the piston-rod from turning in the crosshead and to enable an easy adjustment to be made for piston clearance. The end is extended to cover over the threads. The accompanying table gives dimensions of several sizes of cast-iron nuts, the letters

corresponding to those in Fig. 6. A spanner wrench, which is made to fit the slots in the nut, is usually furnished.

Effect of Mixture Strength and Scavenging upon the Thermal Efficiency of Gas Engines

By W. H. Booth

In some recent tests of a gas engine with different mixtures of gas Prof. Bertram Hopkinson, of Cambridge, England, found a superior efficiency for weaker mixtures, and he attributes this to the now accepted fact of higher specific heat of gases at high temperatures. On this hypothesis the pressures attained at higher temperatures are not what ordinary calculation would show; that is to say, calculation based on a fixed value for the specific heat.

Comparing the actual with the ideal efficiency, Professor Hopkinson's tests showed that for a mixture of 8.5 per cent. of Cambridge coal gas the efficiency ratio was 0.87, and when the mixture was raised to 11 per cent. gas the efficiency ratio was only 0.83 of the ideal (air diagram) efficiency; less heat is lost to the walls and this contributes to the betterment of the ratio. The following table gives the results obtained in a series of trials:

Gas.		Mean Effec. Press.	Thermal Efficiency, Per Cent.	Duty.
Cu.Ft. per Suction Stroke.	Percentage of Cylinder Capacity.			
0.1275	11.0	102.2	32.5	Full load
0.1147	10.0	98.4	34.7	Full load
0.1005	8.65	90.2	36.5	Full load
0.1275	9.5	108.4	34.5	Light load
0.1140	8.5	101.6	36.1	Light load

As the above were taken all within three hours, it was assumed that the gas did not vary in calorific capacity, which was taken at 600 B.t.u. per cubic foot (lower hydrogen value), because this figure was found by a test "a day or two after."

The diagrams were not taken with an ordinary indicator but photographically by an optical indicator, and the gas consumption was measured by the fall of a standardized gas-holder in the course of 40 or 50 suction strokes of the engine.

Within the range of mixtures that could be employed the difference between the weakest and the strongest charges amounted to only 4½ per cent. in efficiency and 12 per cent. in work done, and so far as analysis showed there was no appreciable loss in unburned combustible gas with any of the mixtures that were tried.

The author of the paper appears to have a correct idea of where the loss takes place with the strong mixtures, namely, at the explosion end of the cylinder. It has always appeared to me, since investigating the good results obtained some years ago by Mr. Thwaite with blast-furnace gas and retarded ignition that it was economically and mechanically wrong to attempt to obtain from a gas engine an indicator diagram like that of the steam engine with a vertical admission line. Such a diagram from a gas engine means high temperature and high pressure when the piston is standing still and no work is being done, although there is every opportunity for heat absorption by the water jacket. Then, though the piston is at rest during a part and moving slowly during the other part of the period in question, both the crank-shaft and crank-pin are rotating at full velocity under maximum pressure and are therefore consuming energy by friction.

On the whole, the professor ascribes one-half of the additional work per cubic foot of gas in the weaker mixtures to the lower specific heat and one-half to the reduced heat losses during explosion and expansion.

As to the effect of light loads with scavenging strokes in between them, it appears that whereas a gas charge of 0.1275 cubic foot gave a mean pressure of 108.4 pounds on light load it gave only 102.24 on full load; and a charge of 0.1000 at full load and one of 0.1140 at light load, corresponding to a mixture of 8.5 per cent. in each case, gave approximately the same efficiency (37 per cent.). The agreement of the mixture percentages was due to the different cylinder temperatures, the light load temperature being lower and allowing more air to enter the cylinder and balance the heavier charge of gas. But, generally, the pressures following the scavenging strokes were not so consistently regular as the full-load pressures. This was due to variation in the suction temperature, which in the calculations is assumed to be 50 degrees Centigrade for the light-load and 100 degrees Centigrade for the full-load strokes. But the combustion of a charge following a scavenging stroke was found not to be complete, the unburned fuel amounting to as much as 4 to 5 per cent.

GAS COMPOSITION, BY VOLUME.

Constituent.	Percentage.	O Required for Combustion.	Steam Produced.	CO_2 Produced.
H	47.20	23.6	47.2	
CH_4	35.20	70.4	70.4	35.20
Heavy hydrocarbon	4.80	22.6	16.0	14.40
CO	7.15	3.6	....	7.15
N	5.40			
Other losses	6.25			
	100.00	120.2	133.6	56.75

The engine experimented on had a cylinder 11½ inches in diameter and 21 inches stroke, with a compression space of 407 cubic inches and a compression ratio of 6.37.

The Cambridge gas used had the composition given in the accompanying table.

The higher calorific value ranged from 630 to 680 B.t.u. and the lower value from 570 to 620 B.t.u. per cubic foot.

A Contractor's Boiler

By Ernest Vanarsdel

Referring to the accompanying photograph of a boiler which is being used by the contractor having charge of the construction of a sewer system at Shelbyville, Ky., it is interesting to note the manner in which some boilers are connected up and operated.

A CONTRACTOR'S BOILER

There are no gage cocks, and I would not like to venture a guess as to the amount of pressure necessary to raise the safety valve, to which is wired a 12- or 15-pound rock.

The British Consul at Budapest ascribes the recent scarcity of coal in Hungary to two causes: First, to the deficient exploitation of coal mines, chiefly owing to the lack of workmen; and secondly, to the inadequacy of the arrangements for the transport of the coal. It is estimated that about 200,000 metric tons of Cardiff coal had to be imported at high prices into the country last year, while Hungarian coal mines were left in part not worked.

It's better to be too careful for 50 years than to be careless once.

Effects of Superheating Moist Steam*

Some Practical Reasons Why Boilers Must Deliver Dry Steam in Order That Best Results May Be Obtained from Superheating

BY J. C. WILLIAM GRETH

Continued demand for greater economy in operating steam-actuated machinery has, to a considerable extent, brought into use superheated steam. Superheated steam will increase the economy of any steam plant—first, by preventing the passage of moisture from boiler to engine, since moisture wastes heat and does no work; second, by reducing the number of pounds of water to be evaporated by the boiler, as the water mechanically carried from the boiler and that condensed in steam lines, cylinders, etc., does no work; third, by preventing condensation in steam lines and cylinders.

A number of problems in connection with making superheated steam have developed, among them the scaling of the superheater, and the passage of particles of foreign matter with the superheated steam that scale and cut the steam lines and machinery. This is not a new condition, but one that has always existed, due to the fact that boilers as a rule do not make dry steam. The impurities carried with the moisture of saturated steam give little or no trouble, unless they happen to be corrosive or sufficient in amount to cause trouble in the operation of the engines.

To obtain the maximum efficiency from superheated steam with minimum attention and repairs to the superheater, connections and machinery with which the steam comes into contact, it is essential that the boiler which supplies the saturated steam to the superheater should furnish steam that is actually dry, not "commercially dry."

Impurities, Soluble and Suspended, in Boiler Feed

For boiler feed-water, we are dependent upon natural supplies which are rarely, if ever, found pure. Water, being the greatest solvent known, carries in solution varying quantities of those substances with which it has come in contact, such as the carbonates, sulphates, chlorides and nitrates of lime, magnesia and sodium, some silica, oxides of iron and alumina, volatile and organic matter, carbonic acid, sometimes sulphuric acid, and generally more or less suspended matter.

Making steam from natural waters carrying in solution some or all of these substances, with or without suspended matter, affects to a large extent the economy of boiler operation by the formation of scale, corrosion and the varying amounts of sludge formed by the action of heat and concentration on the soluble impurities and the suspended matter introduced.

The attempt is often made to prevent scale and corrosion by the introduction into the boiler of various substances usually spoken of as "boiler compounds." If these compounds are used in sufficient quantity and are adapted to the particular water in which they are used, they will prevent the formation of scale and corrosion, but will not remove the scale-forming matter. It is still in the boiler, together with the compound, forming a muddy, insoluble mass suspended in the water, as well as soluble salts in an ever-increasing amount, due to concentration, so that all that has been accomplished is a change in the nature and an increase in the amount of the substances, but not their removal.

Removal of Impurities

Suspended matter can all be removed from any water by sedimentation and filtration. The lime and magnesia salts can be practically removed by softening and purifying the water by chemical treatment. This process is thoroughly practicable and can be accomplished economically and efficiently at small cost. The purified water will not form scale, or corrode, as it will be soft and clear, making it possible to operate the boilers at the lowest possible cost, as well as to make steam carrying the least quantity of moisture, and that moisture carrying a minimum of foreign matter with it.

By this process there remains in the water, however, all the sodium salts of the raw water (as it is impossible to remove them by any treatment other than distillation), and also the sulphate, chloride and nitrate of sodium resulting from the reaction of soda ash with the sulphates, chlorides and nitrates of lime and magnesia which may have been in solution in the raw water. In very few cases barium carbonate is employed to precipitate the sulphates of lime and magnesia, without leaving any soluble salts as a result of the reactions.

The following analyses of water before and after treatment will illustrate what is accomplished by this process:

RAW.

	Grains per U.S. gallon.
Volatile and organic matter	3.60
Silica	0.30
Oxides of iron and alumina	trace
Calcium carbonate	11.84
Calcium sulphate	8.43
Magnesium carbonate	5.25
Magnesium chloride	1.53
Magnesium nitrate	4.73
Sodium chloride	2.37
Total solids	38.05
Suspended matter	0.05
Free carbonic acid	2.37
Incrusting substances	35.68

TREATED.

	Grains per U.S. gallon.
Volatile and organic matter	0.40
Silica	0.17
Oxides of iron and alumina	trace
Calcium carbonate	1.45
Calcium sulphate	0.15
Magnesium hydrate	0.49
Sodium sulphate	8.90
Sodium chloride	4.21
Sodium nitrate	5.34
Total solids	21.11
Free carbonic acid	none
Incrusting substances	2.66

The lime and magnesia salts left in this water are too small in amount to form scale, but will form a small amount of sludge. This sludge, together with the sodium salts, will continually concentrate, along with the evaporation of the water. It can be readily seen, however, that this concentration will be materially less, using the softened water, than if the raw water were fed into the boiler, with or without compound.

In many plants surface condensers are used, especially with steam turbines. The condensed steam is returned to the boilers, but only in rare instances is the amount sufficient to operate the boilers. Make-up water is necessary, and this is generally some natural supply, more or less impure, which at best means sludge and the concentration of the soluble impurities.

Solubility of Scale-forming Substances at Boiler Temperatures and Pressures

It is generally maintained that the water at boiler temperatures and pressures will not carry in solution the scale-forming substances, such as calcium carbonate, magnesium carbonate, calcium sulphate, magnesium sulphate, calcium chloride and magnesium chloride. This is true to a certain extent.

Calcium carbonate owes its solubility in water to the presence of carbonic acid. Driving off the carbonic acid will precipitate nearly all the calcium carbonate, but some of it will remain in solution, the amount depending on the other substances in solution. Magnesium carbonate is often

*Copyright, 1908, by J. C. William Greth.

decomposed into the hydrate, which is less soluble; still nearly all blow-off waters from boilers fed with water containing magnesium carbonate will show either the carbonate or the hydrate, sometimes both.

Calcium sulphate is supposed to be insoluble at temperatures above 300 degrees Fahrenheit, but the analysis of blow-off waters where temperatures far above 300 degrees Fahrenheit are maintained, has shown as much as 25 grains of it in solution per United States gallon. Magnesium sulphate and calcium chloride are both very soluble at all temperatures. When magnesium chloride is present in the raw water the boiler blow-off analysis usually shows magnesium hydrate.

But the substances which most persistently remain in solution are the sodium salts. This is illustrated by the following analyses. The first is the analysis of the well water fed into the boiler, the second that of the concentrated boiler water.

WELL WATER.

	Grains per U.S. gallon.
Volatile and organic matter	1.15
Silica	0.15
Oxides of iron and alumina	trace
Calcium carbonate	2.00
Calcium sulphate	3.12
Magnesium sulphate	1.26
Sodium sulphate	43.88
Sodium chloride	1.65
Sodium nitrate	0.24
Total solids	53.45
Suspended matter	0.25
Free carbonic acid	0.22
Incrusting substances	7.68
Non-incrusting substances	45.77

CONCENTRATED BOILER WATER.

	Grains per U.S. gallon.
Volatile and organic matter	1.75
Silica	0.65
Oxides of iron and alumina	trace
Calcium carbonate	2.98
Calcium sulphate	25.57
Magnesium sulphate	7.44
Magnesium hydrate	0.15
Sodium sulphate	717.10
Sodium chloride	18.95
Sodium nitrate	1.02
Total solids	775.61
Suspended matter	10.65
Incrusting substances	38.54
Non-incrusting substances	737.07

Concentration of Water in Boilers

This concentration of the water in the boilers cannot be prevented, even with regular blowing off. There is a precipitation of scale-forming matter, some of which is removed by the blow-off as suspended matter, especially in those types of boilers in which mud-drums are provided and the circulation is such that will allow the suspended matter to settle near the blow-off. The sodium salts, the scale-forming salts to the limit of solubility, and the suspended matter not collected in the mud-drum, as well as that formed by being forced out of solution due to the evaporation of the water, are practically uniformly diffused in the water in the boiler, and by blowing off soluble and insoluble impurities are removed in direct proportion to the amount of water blown off, plus the suspended matter collected near the blow-off.

The difference in the water taken from the blow-off cock and the gage column is the presence of a larger amount of suspended matter from the blow-off cock, with greater concentration of the soluble salts in the water from the gage column, depending on the type of boiler and the circulation in the boiler.

For instance, take the following example of a 250-horse-power boiler operating at rated capacity, fed with a water of uniform composition, under the conditions hereinafter stated.

Evaporation per hour, 31.2 pounds per horse-power (assumed for convenience); contents of boiler at normal water level and in regular operation, 26,000 pounds of water, or 104 pounds per horse-power; blow-off, 1238 pounds (about 3 inches measured at the gage glass) every four hours, after which the boiler is filled to normal level to replace the blow-off water.

By use of the following method the number of concentrations is obtained:

Let the run be divided into equal periods, each ending when the water blown off has been replaced by fresh feed; let the first period begin when the boiler has been filled to normal level and heated to steam. Then let E = the evaporation per horse-power per hour, C = the contents per horse-power, and H = the number of hours in each period, or the number of hours between blow-offs. Then, with no blow-off the feed required during each period would be $\frac{EH}{C} = F$ times the horse-power.

Let the ratio

$$\frac{Blow\text{-}off}{Total\ Contents} = B;$$

then the ratio

$$\frac{Remaining\ Water}{Total\ Contents} = 1 - B = R.$$

Let the concentration of the fresh water at the beginning of the period $= 1$; then near the end of the first period, before the blow-off, $1 + F$; after the blow-off $(1 + F)R$; and after replacing the blow-off, for the end of the first period, $(1 + F)R + B = R + FR + B$.

In the same way for the second period we get: Before the blow-off, $R + FR + B + F$; after the blow-off, $(R + FR + B + F)R$; and after replacing the blow-off, or at the end of the second period, $(R + FR + B + F)R + B = R^2 + F(R + R^2) + B(1 + R)$; for end of the third period, $R^3 + F(R + R^2 + R^3) + B(1 + R + R^2)$; for end of the fourth period, $R^4 + F(R + R^2 + R^3 + R^4) + B(1 + R + R^2 + R^3)$.

Thus, in general, the concentration at the end of the nth period becomes

$$R^n + F(R + R^2 + R^3 \ldots\ldots R^n) + B(1 + R + R^2 \ldots\ldots R^{n-1}) =$$

$$R^n + F(R + R^2 + R^3 \ldots\ldots R^n) + \frac{B}{R}(R + R^2 + R^3 \ldots\ldots R^n) =$$

$$R^n + \left(F + \frac{B}{R}\right)(R + R^2 + R^3 \ldots\ldots R^n);$$

or, summing the series,

$$R^n + \left(F + \frac{B}{R}\right)\frac{R}{1 - R}(1 - R^n);$$

or, since $1 - R = B$, the concentration $=$

$$R^n + \left(\frac{FR}{B} + 1\right)(1 - R^n);$$

let $\left(\frac{FR}{B} + 1\right) = K$ and the summation $=$

$$R^n + K(1 - R^n) = K - (K - 1)R^n.$$

Therefore, the concentration at the end of the nth period equals $K - (K - 1)R^n$, where

$$K = \frac{FR}{B} + 1 = \frac{EH}{C} \cdot \frac{R}{B} + 1.$$

In the special case above: Where

$$B = \frac{1238}{26{,}000} = \frac{1}{21},\ R = \frac{20}{21},\ \frac{E}{C} = \frac{31.2}{104} = \frac{3}{10},$$

$$H = 4,\ \frac{EH}{C} = \frac{6}{5} \cdot \frac{R}{B} = 20,$$

and

$$K = \frac{EH}{C} \cdot \frac{R}{B} + 1 = \frac{6}{5}(20) + 1 = 25$$

Concentration at the end of the twenty-fourth period equals $K - (K - 1)R^{24} = 25 - 24\left(\frac{20}{21}\right)^{24} = 25 - 24 \times 0.3101 = 25 - 7.44 = 17.56$ times that at the start.

It is thus evident that even with blowing off to the extent as above, instead of 28.8 concentrations there have been 17.56 concentrations. In other words, with a water carrying in solution 10 grains of salt, none being carried out with the steam or by blowing off, the concentration would increase the amount to 288 grains; with blow-off, as above, to 175.6 grains. Such blowing off is not followed out in practice, as it is rarely the case that 3 inches is blown off at one time or at intervals of four hours; consequently, in regular boiler operation there will be a greater concentration than has been indicated in the example. Even if a greater quantity is blown off and the intervals shorter, there will still be some concentration. In other words, concentration cannot be prevented.

Moisture in Steam Carries Impurities

If a boiler fed with impure water makes steam which carries any moisture with it, that moisture, irrespective of the amount, will carry with it some of the impurities that were dissolved or suspended in the boiler water. If the amount of these impurities is small and the steam carries only a low percentage of moisture, of course the amount of impurities carried with it will be correspondingly small. Now, if the boiler is supplying steam to the engines, etc., direct, a deposit will be formed in the steam lines, separators and traps; in fact, everything will show a deposit similar in composition to the substances in solution and suspension in the water in the boiler.

The following analysis represents an

almost ideal natural supply for boiler-feed use:

	Grains per U.S. gallon.
Volatile and organic matter	1.15
Silica	0.45
Oxides of iron and alumina	0.10
Calcium sulphate	0.97
Magnesium carbonate	0.29
Magnesium sulphate	0.19
Sodium sulphate	0.60
Sodium chloride	2.64
Total solids	6.39
Suspended matter	1.95
Free carbonic acid	1.00
Incrusting substances	3.15
Non-incrusting substances	3.24

The analysis of the concentrated boiler water, after 55 hours of operation with compound, was as follows:

	Grains per U.S. gallon.
Volatile and organic matter	15.90
Silica	9.51
Oxides of iron and alumina	0.20
Calcium sulphate	3.23
Calcium silicate	7.91
Magnesium carbonate	3.11
Sodium sulphate	18.60
Sodium chloride	15.01
Sodium nitrate	1.10
Total solids	74.57
Suspended matter	10.70
Incrusting substances	39.86
Non-incrusting substances	34.71

No analysis was made of scale in the steam piping, although there was abundant evidence at all leaks along the steam line where the evaporation of the water left behind a considerable deposit, but an analysis of condensed steam taken from the discharge of a steam trap connected to a separator in the main steam line shows the following:

	Grains per U.S. gallon.
Volatile and organic matter	0.45
Silica	0.05
Oxides of iron and alumina	0.10
Calcium carbonate	0.13
Calcium sulphate	0.20
Magnesium carbonate	0.04
Sodium chloride	0.08
Total solids	1.05
Suspended matter	0.55
Free carbonic acid	0.22
Incrusting substances	0.97
Non-incrusting substances	0.08

Superheated Steam Carries Impurities Mechanically

If steam carrying moisture from the boilers is supplied to the superheater, this moisture carries with it the impurities of the water in the boiler. These impurities are deposited in the superheater by the evaporation of the moisture into steam before superheating can begin. If these impurities were all deposited in the superheater, they could be removed by cleaning the superheater, provided it is so designed that it could be cleaned, but some of the impurities are mechanically carried through the superheater into the steam lines and to the steam-actuated machinery. The result is increased wear and tear, due to the cutting action of these fine crystalline impurities carried at high velocity. This undoubtedly accounts for the cutting action of superheated steam, which is probably not due to the steam at all, but to the impurities in the steam.

The following analysis shows a water made up of a mixture of condensed steam from surface condensers and well water which was softened and filtered before being fed into water-tube boilers supplying steam to superheaters of the same make as the boilers:

	Grains per U.S. gallon.
Volatile and organic matter	0.20
Silica	0.40
Oxides of iron and alumina	trace
Calcium carbonate	1.02
Calcium sulphate	0.53
Magnesium carbonate	0.42
Magnesium hydrate	0.29
Sodium sulphate	9.69
Sodium chloride	5.11
Sodium nitrate	0.39
Total solids	18.05
Suspended matter	0.05
Incrusting substances	2.86
Non-incrusting substances	15.19

After operating for 168 hours, the boilers fed with this mixed water contained water of the following composition, the sample being drawn from the gage column on the boiler:

	Grains per U.S. gallon.
Volatile and organic matter	0.15
Silica	0.65
Oxides iron and alumina	trace
Calcium carbonate	2.50
Calcium sulphate	1.13
Magnesium hydrate	0.12
Sodium sulphate	282.93
Sodium chloride	117.00
Sodium nitrate	10.86
Sodium hydrate	7.44
Total solids	422.78
Suspended matter	36.40
Incrusting substances	4.55
Non-incrusting substances	418.23

The boilers in question were guaranteed to furnish steam carrying less than 1 per cent. of moisture, when operated at their rated capacity, and not over 1½ per cent. of moisture when operated between their rated capacity and 50 per cent. overload.

Scale Analysis

A considerable deposit of scale was found in the superheater and in the piping connected with the superheater. This scale analyzes about as follows:

	Per cent.
Sodium sulphate	55
Sodium chloride	35
Calcium carbonate	2
Ferric oxide	2
Aluminum oxide	2
Organic matter	2
Silica	1
Magnesium hydrate	1
Total	100

This analysis shows a close relation between the water in the boiler and the scale formed in the superheater.

It is possible that some of this scale was deposited in the superheater, due to flooding before the superheater was put into use. The water used for flooding is usually taken from the boiler and, of course, carries with it whatever is in suspension or solution. But the very soluble sodium salts of the preceding analysis are certainly not deposited in this way; these impurities are, therefore, continually carried into the superheater with the saturated steam, and must be deposited either in the superheater or along the steam lines which it supplies.

It connection with this particular plant, steam turbines are operated. On the pilot valves of the Parsons turbine a deposit forms which is about of the following composition, arranged in probable order of amount: Sodium sulphate, sodium chloride, calcium carbonate, calcium sulphate, iron oxide, aluminum oxide, silica, organic matter, magnesium hydrate.

About 90 per cent. of this deposit is sodium sulphate and sodium chloride. From this it would seem evident that not only is there a deposit in the superheater due to the moisture carried with the steam from the boiler, but some of the substances in solution are mechanically carried along with the superheated steam and deposited in the steam lines and in the various apparatus with which it comes in contact. A number of tests were made of the quality of the steam supplied by these boilers to the superheater. Moisture was found varying from ½ to about 2 per cent. At times during periods of considerable overload the moisture was as high as 3 per cent.

Taking this particular case, with 1 per cent. moisture in the steam, in a 600-horse-power boiler with superheater, evaporating 30 pounds of water per horse-power per hour, 180 pounds of water per hour will be carried with the steam. On the basis of the water carrying in solution and suspension, as in the previous analysis of the concentrated boiler water, 459.18 grains of solids per United States gallon, every hour 1.41 pounds of solids will be carried with the water from the boiler into the superheater and the steam lines. The water used in the boilers represents an average supply, one low in scale-forming matter; in fact, so low that there was no accumulation of scale in the boilers. The boilers are blown down about 3 inches every six hours, which would, of course, reduce but not prevent concentration.

Analyses of River Water

At another plant operating 500-horse-power water-tube boilers, with superheaters, the boiler feed is river water of the following analysis:

	Grains per U.S. gallon.
Volatile and organic matter	1.70
Silica	0.35
Oxides iron and alumina	0.10
Calcium carbonate	2.50
Calcium sulphate	1.33
Magnesium sulphate	0.81
Magnesium chloride	0.29
Magnesium nitrate	0.14
Sodium chloride	1.13
Total solids	8.35
Suspended matter	1.15
Free carbonic acid	0.44
Incrusting substances	7.22
Non-incrusting substances	1.13

The concentrated boiler water, after 75 hours' run with regular blowing off, was analyzed as follows:

	Grains per U.S. gallon.
Volatile and organic matter	3.30
Silica	0.25
Oxides of iron and alumina	trace
Calcium carbonate	4.00
Calcium sulphate	13.12
Calcium chloride	0.16
Calcium nitrate	1.98
Magnesium chloride	0.33
Sodium chloride	12.77
Total solids	35.91
Suspended matter	107.10
Incrusting substances	23.14
Non-incrusting substances	12.77

The superheater in this case contained a scale of about the following composition:

	Per cent
Sodium chloride	59
Calcium sulphate	12
Calcium carbonate	9
Magnesium hydrate	6
Aluminum oxide	2
Iron oxide	3
Silica	2
Volatile and organic matter	7
Total	100

This scale shows not only in the superheater, but in the joints along the steam lines. The boilers at this plant were making steam containing from ½ to 1½ per cent. of moisture, this moisture being carried into the superheater, and there part of the foreign matter was deposited, the remainder being carried into the steam lines.

Cutting Action of Superheated Steam

A great deal of trouble is experienced at these plants due to the cutting action of the superheated steam. It is very probable that substances thrown into mechanical suspension in the superheater act as a sand blast on the valves and with whatever they come in contact. It seems evident from the foregoing that it is absolutely essential that the boiler itself must make dry steam to operate successfully with a superheater. Of course, the quantity of matter carried from the boiler to superheater is small per hour, but a boiler plant operating 24 hours per day, seven days a week, will carry to the superheater a considerable quantity of solid matter, which will be deposited somewhere between the boiler and the exhaust from the steam-driven machinery.

The following table shows about the amount of foreign matter carried to the superheater of a 500-horse-power boiler, with varying percentages of moisture:

Per Cent. Moisture in Steam Supplied to Superheater.	Lbs. of Water Carried into Superheater per Hour.	Lbs. Matter Carried to Superheater, Steam Lines, and Steam Driven Machinery, etc., per Hour.	Lbs. Deposited per Week, 7 Days, 24 Hours per Day.
¼%	75	0.385	64.68
1%	150	0.77	129.36
2%	300	1.54	258.72
3%	450	2.31	388.08
4%	600	3.08	517.44
5%	750	3.85	646.80

The table is on the basis of an hourly evaporation of 30 pounds of water per horse-power, the boiler working at its rated capacity. The water averaged 300 grains per United States gallon, and is a fair average for matter in suspension and solution in cases where boilers are regularly blown off and are emptied at least once a month, washed out, and refilled with fresh water. Boiler manufacturers, as a rule, guarantee that their boilers will make steam at the rated capacity with not over 1 per cent. moisture, but from tests made on a large number of boiler plants, the average moisture in steam is found to be considerably above that figure.

It will be noted that in no case have boilers been considered when operated above their rating, for which a condition much more serious is certain to result, for the following reasons: Greater concentration of water in the boiler; increased moisture in the steam; more steam passing through the superheater and piping; heavier deposit in the superheater; more solid matter mechanically carried with the steam and probably at a higher velocity.

The boiler evaporates more water, hence greater concentration. The increased evaporation causes the steam to leave the boiler with higher velocity, therefore it has less chance to leave behind moisture carried with it into the steam space. Consequently, a larger per cent. of moisture with more solids in solution, due to the greater concentration, will be carried into the superheater, causing a greater deposit of solids in the superheater and piping, and the higher velocity of the superheated steam laden with mechanically carried solids in greater quantity due to this higher velocity will cause more damage to machinery with which it comes in contact.

Take, for instance, the case of the 500-horse-power boiler in the previous table, operated at 750 horse-power. With 1 per cent. moisture we have 225 pounds of water passing into the superheater per hour, carrying 1.16 pounds of solids per hour.

The moisture carried over to the superheater must necessarily reduce the efficiency of the superheater, as heat must be supplied to change the water into steam before the superheating can begin. The deposit of scale in the superheater must also affect its efficiency in time, even when the steam carries but 1 per cent. moisture. In this case, on the 500-horse-power boiler in the table, 129.36 pounds of solids are carried into the superheater in one week, the greater part of which is undoubtedly deposited in it. So a serious drop in the efficiency must necessarily result.

Successful Superheating Requires Dry Steam from Boilers

This brings up the question of designing and operating the boilers to make dry steam. It is practically impossible to obtain waters which do not contain some substances in solution, unless the waters are first distilled before being fed into the boilers. This is impracticable, as the cost of distilling would more than offset any advantage which might be gained by the superheating, and unless the boilers can be designed to make steam which will be free from moisture it will always be difficult to get the best results from the superheater, or from machinery operated with superheated steam.

The examples given represent only average conditions, but there are conditions much more serious. For instance, a boiler plant operating on a water which analyzes as follows:

	Grains per U.S. gallon.
Volatile and organic matter	2.25
Silica	0.75
Calcium carbonate	11.41
Calcium sulphate	5.85
Magnesium carbonate	5.56
Magnesium chloride	1.77
Magnesium nitrate	1.51
Sodium chloride	0.12
Total solids	29.22
Suspended matter	0.10
Free carbonic acid	0.99
Incrusting substances	29.10
Non-incrusting substances	0.12

It was impossible to obtain at this plant a sample of the concentrated boiler water. Compounds of every kind were used to prevent scale formation, but the trouble with the superheaters, steam lines, turbines, etc., could not be stopped.

At this plant the superheater showed a considerable deposit of scale, made up largely of calcium carbonate, magnesium hydrate and sodium salts. It was necessary to clean the scale out of the superheater every week, to keep it in condition to produce superheated steam of the desired temperature. Parts of the steam lines, the valves beyond the superheater and those in connection with the steam turbines had to be frequently cleaned and often renewed. The softening of this water would have materially cut down the deposit in the superheater, as well as in the steam lines, and undoubtedly would have increased the life of the parts of the turbine, but the water would still have carried a certain amount of matter in solution, and while the superheater would have continued to accumulate scale, the amount would have been materially reduced. It is, therefore, essential that the boiler make steam which does not carry moisture from the boiler, and until this problem is solved, the superheater, on account of increased cost of maintenance, will not show the anticipated economy.

The installation of an efficient steam separator between the boiler and the superheater (provided one can be built) would probably prevent deposits in superheaters and pipe lines. The use of some sort of screen at the outlet from the superheater, which would catch the fine crystalline matter mechanically carried with the superheated steam, would materially improve conditions. These are only makeshifts and the result only problematical, as separators or screens of

the required efficiency might not be practical or possible.

If pure water could be obtained for boiler feed, or if the concentration in the boiler of the impurities in the water could be avoided, little trouble would exist, but the first is possible only in rare instances, the second impossible. The proper remedy for existing conditions is so to design steam boilers that they will make dry steam, or install a separator between the boiler and the superheater that will remove all of the moisture in the steam coming from the boiler, and thus prevent the impurities carried with the moisture from entering the superheater.

Lining-up a Horizontal Engine

By C. R. Strother

About three years ago the writer had charge of a good sized plant where ash haulers, water tenders and firemen were employed. As chief, I always endeavored

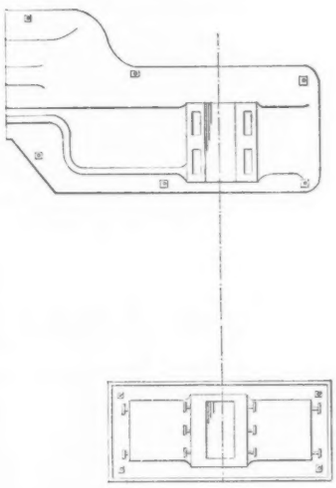


FIG. 2

to explain anything that was asked to the best of my ability, and being a subscriber to several engineering papers, I didn't keep them locked up as most do, but would let them read when they were off watch. Very little interest was taken at first, but after a while the boys looked forward to the papers with as much eagerness as they did to lunch time.

Now this article is intended for the water tender, ash hauler and firemen (as to the practical engineer, the lining up of an engine is an easy thing) and while the methods used are old, there may be a few things that will be new to some.

The figures show the different methods of using the line, which should be very fine and also stout, in order to be drawn tight without breaking. We will start with a new engine just off the car, about a 15x16-inch automatic, with outboard bearings and side crank.

After getting the engine in on the foundation and before letting it down on the masonry, wedges like Fig. 1 should be placed under the engine for leveling up. On some engines the barrel type of guide is used and on others the locomotive type, only the crosshead is different. We will take the barrel type of guide for this engine. A scale is put across the guides

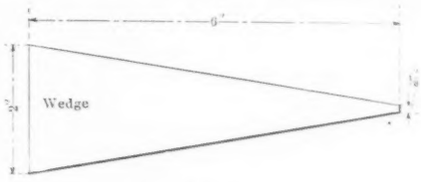


FIG. 1

and a spirit level on top of the level. If the engine shows low, the wedges should be driven in farther on the low side, and after getting the engine leveled crosswise, it should be leveled lengthwise, by placing the level on the guides lengthwise and adjusting the wedges as before.

After getting the engine leveled, it should be fastened down as tight as possible, being sure that the engine is in line with the building, for if a generator is belted to the engine and the belt centers are long, the generator will be out of line with the building as well as the engine.

Now the outboard bearing is ready to be set and wedges should be used as on the engine, and after placing the bearing on the wedges the anchor bolts should be tightened up just enough to hold the bearing in place. Put the back quarter boxes of the engine and outboard bearing in their places, being sure that they are in place and run a line through to the engine. Note if the line touches all four of the corners of the boxes on the engine and outboard bearing, and if it does, the outboard bearing is in line with the engine.

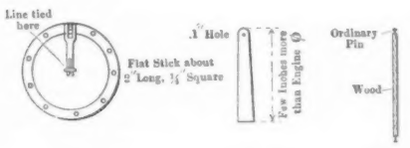


FIG. 3 FIG. 4 FIG. 5

If the line touches three sides only (see Fig. 2), the bearing should be shifted until the line does touch the four corners of the two bearings. The adjusting bolts in the sole-plate should not be disturbed at all unless the pedestal is not in the center, and in that case the pedestal should be run to the center and lined up with the engine.

The cylinder-head can now be taken off and the head and rod taken out, but before backing off the rod from the crosshead, the position of the rod should be noticed and marked, using a tram or pair of dividers. If there is no prick-punch mark on the rod, one should be made, and also on the crosshead, and a pair of dividers should be used to determine the distance between the two marks. This distance should be written down in a note book. The best way is to set the dividers to a certain distance and then make the marks to that.

After the head is out, the crosshead can be removed, and as the connecting-rod is off when the engine arrives, a line can be run through the cylinder and a device used to hold the line in place on the head, as shown in Fig. 3. This is a piece of wood slotted large enough to fit one of the stud-bolts that hold the head on, while

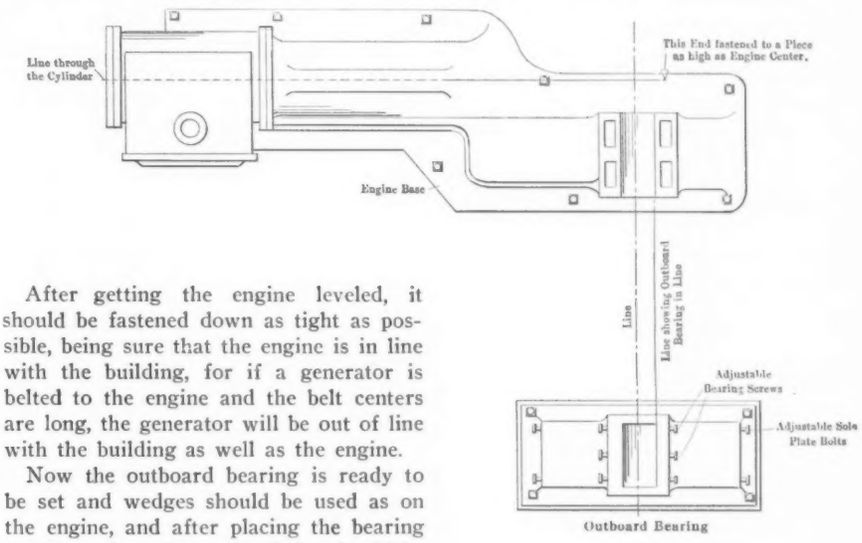

Line through the Cylinder
This End fastened to a Piece as high as Engine Center.
Engine Base
Line
Line showing Outboard Bearing in Line
Adjustable Bearing Screws
Adjustable Sole Plate Bolts
Outboard Bearing

FIG. 6

the other end is slotted about ½ inch, so the line will clear freely. The board should be long enough to reach a little past the center of the cylinder and be about 1 inch thick, a piece of wood about 2 inches long and ¼ inch square being used as a dead-end for the line.

Fig. 4 shows the dead-end at the crank-pin end, which is a piece of wood about 3 inches wide at the bottom and tapering toward the top to about 2 inches, with a hole cut in the top as near the center of the engine as possible. The line is made fast on the crank-end first, passed through the stuffing-box to the lining board, where it is drawn up tight and made fast with the 2x¼-inch block, which being flat will not turn.

Now with the "feeler," Fig. 5, which is a piece of wood rounded up and about 1 inch shorter than half the diameter of the cylinder and with pins on each end to make up the inch, the line is adjusted by placing one end of the pin on the cylin-

der and noting the position of the line as to whether it is above or below the pin. If above the pin, the line will have to be lowered, and by adjusting the line in this manner it may be centered on the head end and similarly on the crank end, but instead of adjusting the board on the head end, the floor stand will have to be adjusted. The line that runs through the cylinder and the line that runs to the outboard bearing will cross as seen in Fig. 7.

After the fly-wheel is placed on the shaft, it is ready to be placed in the bearings, and care must be taken to keep all grit out, as well as not to batter up the bearings as the shaft is being lowered in place. After the shaft is in place, it should be leveled up and then the anchor bolts should be drawn down tight and any other adjustment can be made with the adjusting bolts on the sole-plate.

The shaft should now be placed on one of the centers and noted if the line strikes the crank-pin in the center, Fig. 7, which it will if the outboard bearing has been lined properly. After trying this center, turn the engine over to the next center and note if the line is in the center of

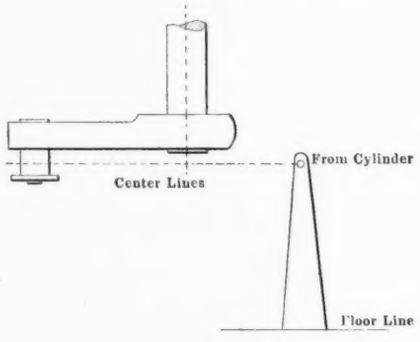


FIG. 7

the pin on this point. If the shaft is level and in line the pin will show up the same all the way around.

The crosshead can now be placed and the piston and rod can also be put in place. When the rod is screwed up in the crosshead, the punch marks should come as they were before, and this can be determined by the dividers. Before the cylinder-head is put on, a coat of graphite and cylinder oil should be given the cylinder.

Next to put in place is the connecting-rod, and it should not be taken up too tight at first, as a new engine will run warm sometimes no matter how good a bearing is worn.

On a new engine, the method of using the feeler in any part of the cylinder will work, but on an old engine that has been running for some time and the cylinder is worn badly, the feeler would not accurately locate the line. In this case the line should be adjusted at the counter-bore, which would not be worn at all.

With all adjustments made, the engine can be grouted in and bolted down, and after letting the concrete set for a couple of days, it is ready for running. It should be turned over slowly, just admitting enough steam to turn the crank until the bearings are worn to some extent. Then the speed can be increased to about half the regular speed, but close watch should be kept on the bearings to see that they have plenty of oil and are not taken up too tight.

Speed can now be increased up to the point where the governor will pick up and the engine run at this speed for at least an hour, if not longer, in order to get the governor loosened up. After having determined that everything is O. K., the engine can be brought up to speed and the pounds and knocks noted. If there is any, the engine should be shut down and taken up, but not too much, as it's better to let the engine pound some than to burn it.

In regard to taking up the bearings the engineer will have to use his own judgment and be governed according to circumstances, as what will work in one case will not work in another.

After determining that the engine is O. K., the valve-stem should be punched, and this can be accomplished by using the prick punch instead of the center punch, and by making a punch mark on the knuckle of the rock-arm and one on the valve-stem, using the dividers to find the distance of centers and putting it down in a note book. The eccentric-rod should also be marked in the same manner and the distance noted, and as the piston-rod has already been marked, there are only a few more parts to mark, such as the main bearing and the position of the outboard bearing, which can be marked on the cap plate.

Gas Engines in Spain

In many parts of Spain electric power for industrial purposes is supplied at a cheap rate, and small industries can use electric motors. Spain has passed directly from the oil lamp to electric light, and there are comparatively few gas works. Where gas engines are employed, they are generally supplied with a gas-producing plant. The best Spanish anthracite comes from Penarroya, and as this produces specially dirty gas, it is necessary to have plant capable of thoroughly cleaning it. Anthracite is also produced from the mines at Pola de Lena, in the Asturias, Santa Lucia, Leon, and the Guardo mines in the province of Palencia. The quality is not satisfactory.

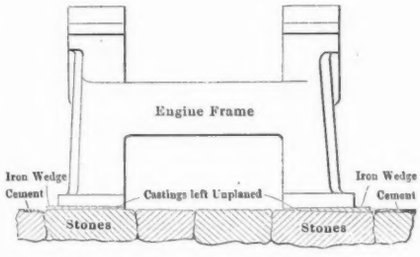
Cast-iron sewer pipe makes an excellent extension for the blow-off pipe when it goes through soot and ashes outside of the building. The only precaution necessary is that the joints be well made with iron borings and sal ammoniac, as lead will work out of the joints. The ground under the pipe should also be well tamped.

An Engine in India

By P. P. Talaty

The engine under description was intended by the maker to develop 700 indicated horse-power for driving a cotton mill. It is a triple-expansion Corliss engine having four cylinders, 16-inch high-pressure, 25-inch medium-pressure and two 27-inch low-pressure, with a 42-inch stroke and a speed of 75 revolutions per minute. The cylinders are placed horizontally and in tandem, and have double-ported Corliss valves. The auxiliary equipment consists of two vertical condensers and two air-pumps working separately in the pit from the engine crosshead.

The cylinders are placed on cast-iron girders, and the guide-frames and main crank-shaft pedestals rest on stones. I was quite astonished to see that the main pedestals and the guide-frames, which are of the box-girder type, were not planed at the bottom. This and other causes made the installation unusually bad. The guide-frames and pedestals were trued up with 2x3x½- to ⅞-inch iron wedges, and the remaining cavities between the stones



STONE FOUNDATION WITH WEDGE AND CEMENT ADJUSTMENT

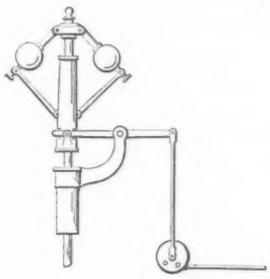
and frame were filled with cement. Naturally the engine was out of line.

From the beginning the mill had a bad start on account of insufficient capital, passing from one owner to the other, and on this account the engine had a bad start, too.

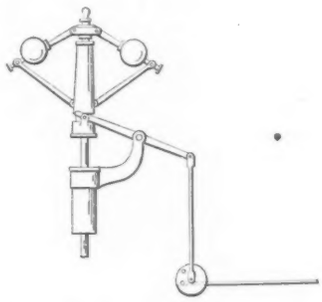
After the mill had been shut down for a couple of years, it was thought advisable to start it up, new machinery having been added, a weaving shed built and repairs made to the air-pumps, which had stuck fast while the engine was idle. The trip-gears and valve setting were also defective and had made a great deal of trouble, as may be seen from the first set of diagrams on page 19. All the relief valves, about ten, and the exhaust pipes would blow so severely that it was necessary to stop the engine often and look for the trouble. The engine was run for about three months this way, when the writer was placed in charge of it.

At first the engine was run slowly, and when stopped at noon it could not be started again, even by putting the high-pressure crank at from 35 to 45 degrees off dead center, so the driver was told to

start as usual, i.e., by running the barring engine to give motion to the main engine, at the same time opening the throttle valve quickly and raising the governor by hand. After the engine was stopped at night, the cut-offs of all the cylinders were examined. That of the high-pressure cylinder only will be considered here, and for the benefit of those who may be interested the method of finding the point of cut-off is given as follows:



MID-POSITION



DOWN POSITION

BROKEN SPRING

How to Find Point of Cut-off

With the governor on the extreme downfall, as usual, find the mark on the guide-frame. If there is no mark, place the main engine on dead center by barring it over. To do this, place a spirit level on any convenient space on the crosshead crank-pin brasses or strap, and when the spirit level shows level, the crank, connecting-rod and piston will all be in line and the engine will be on dead center. With a square on the guide-block, with a sharp point mark on the guide-frame the position of the end of the guide-block. Next, turn the engine to the other center and mark in the same way. After finishing this, put a foot rule even with the mark on the guide-frame and bar the main engine over until the high-pressure catch-piece lets go from its trip-gear; then measure the distance from the dead-center mark to the edge of the guide-block, and this distance will be the length of cut-off for the high-pressure cylinder. Find the cut-off for the other end in the same way; this will be the cut-off for the governor when in the down position.

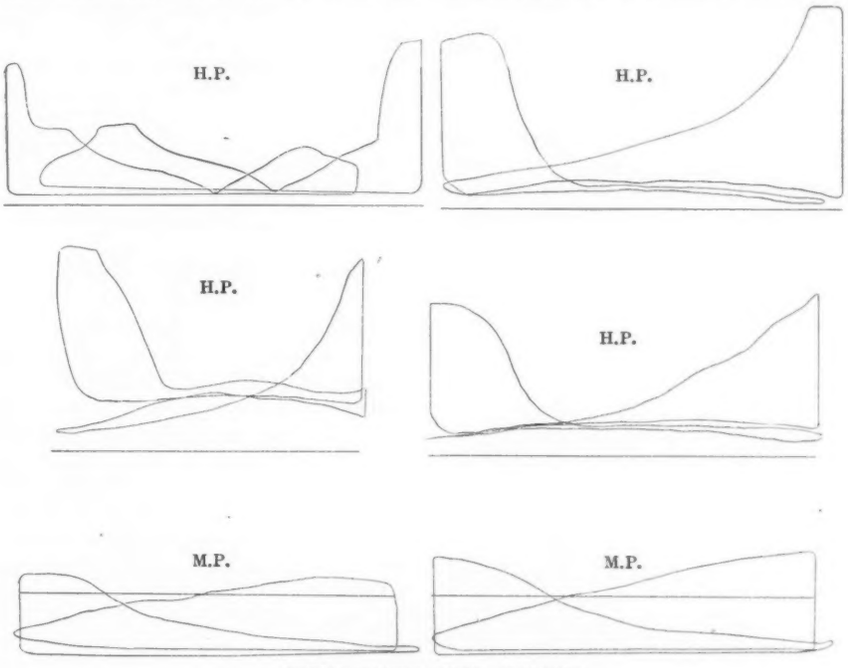
If it is desired to know the cut-off of the engine at full speed, with the governor at its mid-position, observe the length of the governor-rod; then get the calipers and measure the vertical lift of the governor. With two pieces of wood properly squared and of the same hight as the measurement just noted, raise the governor and put the pieces of wood under it. Then bar the engine over and get the cut-off as before. An earlier cut-off will be observed, and it should be noted down, with the other, in a book. Compare both and also compare with the cut-off shown on the indicator diagram. The diagram cut-off will be of longer period, the increase giving an idea of the efficiency of the trip-gear and also some idea of the action of the dash-pot spring. If the spring is too weak, it will close the valve slowly, and this may be noted on the diagram by the long-rounded corner after cut-off.

Adjusting the high-pressure cut-off, as described, did away with the trouble of lifting the governor by hand. The relief valves were still blowing, but not so much. This blowing showed that there was more steam than required; the high-pressure steam passed from one cylinder to the other and then to the condenser, without being fully expanded. For this reason the cut-off was shortened from 5/8 to 1/3 stroke, and to avoid the blowing the relief-valve screws were tightened. At this juncture the high-pressure relief-valve spring broke, and as there was not another in stock, it was thought advisable to grind the end of the spring and use an iron washer and a longer screw, which served the purpose very well.

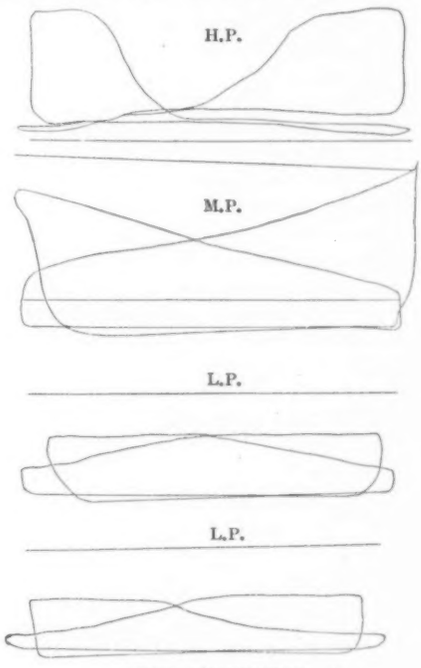
Trouble with Piston-rod Packing

The next trouble was with the piston-rod packing. The high-pressure gland leaked badly. It was of the double-gland type, the inside gland containing three white-metal packing rings, which were broken into many pieces. As there were no white-metal rings in stock it was necessary to cast some new ones from white metal, after making the patterns. These were turned and cut into two pieces and put in place. The gland was then set up again and the leaking entirely ceased.

After these repairs were made it was necessary to set the valves, as may be noted from the first set of diagrams. It was found advisable to shift ahead the common eccentric for the high-pressure and low-pressure exhaust, in order to open the exhaust valves sooner, and close them early, to give compression. This was done gradually until the proper adjustment was finally made. The engine is now running in good shape and gives but very little trouble.



BEFORE VALVES WERE ADJUSTED



AFTER ADJUSTMENT

Practical Letters from Practical Men

Don't Bother About the Style, but Write Just What You Think, Know or Want to Know About Your Work, and Help Each Other

WE PAY FOR USEFUL IDEAS

Mr. Johnson's Turbine Article Criticized

In the issues of March 31 and April 14, articles were presented by F. L. Johnson on the Curtis turbine. In the first-named issue, Mr. Johnson gives certain figures for the amounts and pressures of water for lubricating the step bearings. It would appear that the data were given as a general statement applying to all sizes and types of Curtis turbine. If this is the intention, the data given are not correct. The amounts and pressure of the step-bearing lubricant depends upon several factors, namely, weight of revolving element, speed, and the diameter of the step bearing.

As a general proposition the use of water has been abandoned by the manufacturers of the Curtis turbine and oil substituted, although there are many successful installations using water.

In the issue of April 14, Mr. Johnson shows a drawing and describes a type of bearing which he calls the latest for Curtis turbines; this is particularly for the upper end of the shaft. This is far from correct, as the sleeve type of bearing which he describes is not the latest development in this part of the turbine. In fact, the situation is just the reverse. The sleeve type of bearing is about the latest to be abandoned by the manufacturers of the Curtis turbine and the solid type of bearing substituted. The sleeve type of bearing has been found wanting in many cases and the elimination of it has resulted in a noticeable improvement in the operation of the machine.

The first recollection I have of trouble due to the use of the sleeve type of bearing was as much as nine months ago, the machines having these bearings being manufactured in 1906. The facts are that the supposed new type of bearing is really quite old to those who are familiar with the Curtis turbine.

C. W. E. CLARKE.

New York, N. Y.

Mr. Johnson's description of the loose-sleeve type of bearing is extremely good and explains how these bearings were intended to function. At the time they were adopted all bearings on the vertical turbines manufactured by the General Electric Company were lubricated from a small tank on the top of the machine, from which, of course, the pressure was quite low, and experiments showed considerable improvement by the use of the loose sleeve as a method of maintaining a perfect oil film over the entire surface of the bearing. It is true that if the sleeves grip the shaft the flanges on the bearing would be cut, and if the sleeve is

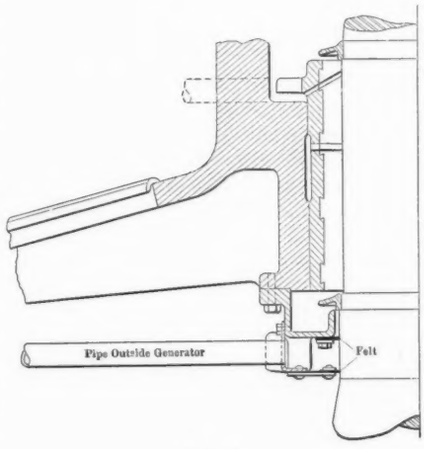


FIG. 1

too loose this would tend to produce some vibration when the machine is running. When the bearings are provided with oil under pressure the necessity for this loose sleeve ceases to exist. For this reason it was abandoned.

The necessity for the prevention of oil

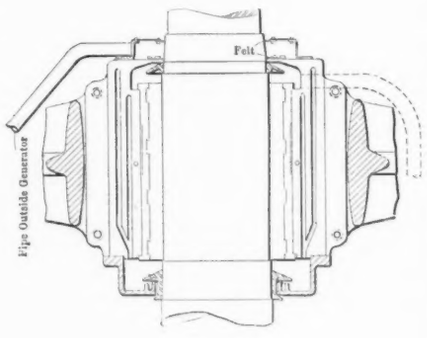


FIG. 2

being thrown into the generator cannot be overestimated, the worst feature being that the oil causes any dust in the air, which is being circulated through the machine, to be deposited, and in extreme cases may effectually stop the openings provided for ventilation, thereby causing the machine to run at a considerably increased temperature.

In many cases oil throwing may be caused by some imperfect arrangements which allow the oil to drain directly out of the pans into the machine, but in most cases trouble from oil is caused by some tendency to circulate air through the oil spaces. This air after passing through the oil pans is charged with a vapor and being drawn into the machine does the damage. To prevent this it is necessary to equalize pressures and prevent such draft or suction of air through the oil spaces. This oil is in a fine spray and is delivered in such small quantities that it can only be detected after operation for a considerable period.

Fig. 1 shows a method of preventing air from being drawn through the oil pan under the top bearing of a vertical turbine-generator, and Fig. 2 shows an application of the same idea to the top end of the middle bearing. The pipes which are marked to be run outside the generator need only be taken to a point where there will be no suction of air.

When considered from this standpoint the use of felt rings can be regarded as a permanent cure.

E. D. DICKINSON,
Turbine Engineering Department,
General Electric Company.

Knocks in Steam Engines

My experience, especially with condensing four-valve engines, is that if the vacuum is lost the compression will be so high that the relief valves will open, and the engine will knock to a considerable extent; and as soon as the vacuum is obtained the engine will run so quietly that there is hardly a sound except from the dash-pots. When running non-condensing, we set the exhaust cams back about 3/8 of an inch and the engine shows practically the same compression on the indicator diagram and runs as quietly as before. It is an old-style Brown side-shaft engine of about 900 horse-power. It is a twin engine, 26 years of age, and I am proud of the way they both run.

In regard to the Massachusetts license law, I will say that I have held and worked under a first-class unlimited license for nearly twelve years, and I have no fault to find with the way I have been used; but I know of cases where great injustice has been done to men who could

give some of the inspectors(?) a good start and lose them early in the game. I know personally of one inspector who could not answer one-third of the questions he asks. My contention is that the State has no right to examine a man as to his fitness to run engines, but that the examination should be on the boiler, its care and operation, and on the feed apparatus and the safety of steam mains. A service clause should be added to the law, also.

WILLIAM S. TROFATTER.

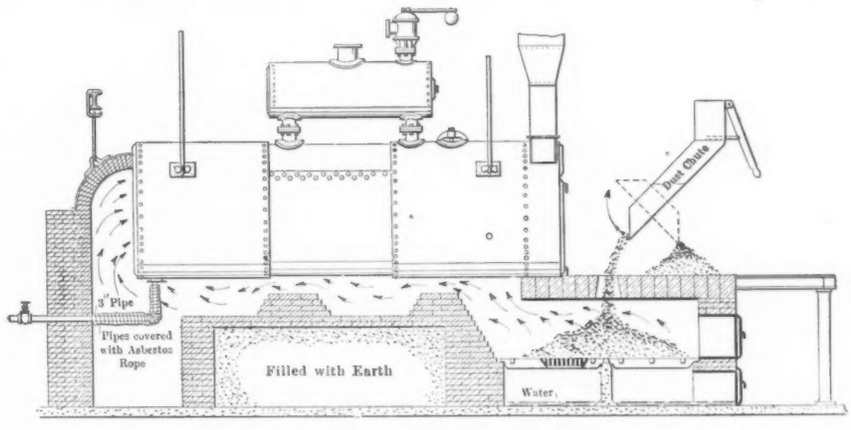
Newburyport, Mass.

Burning Sawdust

Accompanying is a sketch of a furnace which I think is an ideal one for burning sawdust. The honeycomb grate is best for small particles like sawdust, while the style of grate known as the herringbone is best for coarser fuel. The draft is the most important factor, especially where the boiler power is limited. If the furnace has one feed-hole, have that located in the center of the furnace, and be sure to have the furnace as wide as it is long, or else the fires will become blocked out on the sides and the end of the grates will be left bare; if there are more than one feed-hole, the length may exceed the width.

The depth should not be less than two-thirds the diameter of the boiler, and in most cases more should be allowed, especially if using cypress dust as fuel, as the advantages in a dutch oven lies in the depth of the furnace, for the dust at the top of furnace is drying while the lower is burning.

I think that the boiler should be arranged so it can be fed through the blow-off, as well as in the front head or on top, as preferred; also, it should be equipped with an injector and pump, and piped so both can be used at the same time, although it would not be necessary if both are of the proper capacity. It would be more convenient at times, that is all.



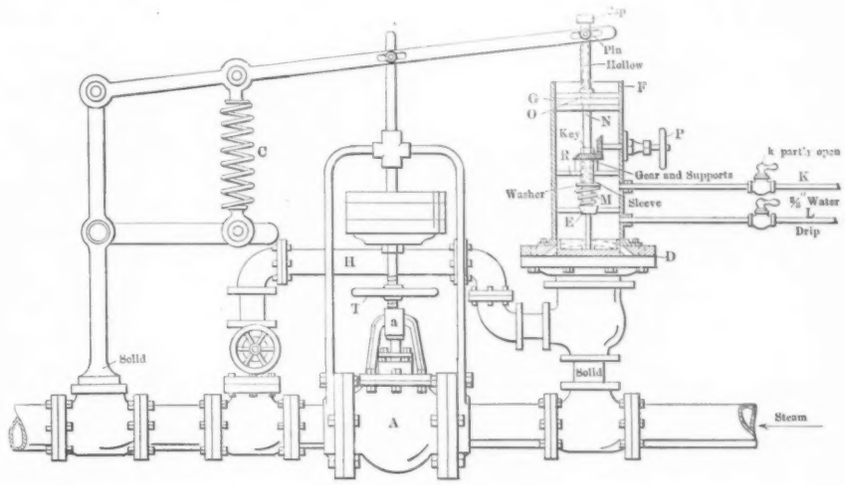
FURNACE LAY-OUT FOR BURNING SAWDUST

A. L. HOWARD.

Wiggins, Miss.

Making a Reducing Valve

Among the small apparatus in a plant where I worked once upon a time was a 3-inch reducing valve, which had an exasperating habit of sticking. I had cured this style of valve before by tapping a lubricator to it, but here, as the condensation was returned to the boiler, this method was not to be thought of. (I would like to ask if any of your readers have had the same trouble with reducing valves where superheated steam was used.) In taking the mechanism of this valve apart, I found an appendage stuck so fast that I broke it in removing. I determined to try my hand at making a reducing valve, but had I known how complicated a thing it was, I hardly think I would have started. The accompanying sketch gives an idea of the "thing" as I remember it.



MAKING A REDUCING VALVE

Referring to the cut, *A* is an old valve with the thread in the guide block *a* removed. Weight plus tension on the spring *C* will shut this valve against 100 pounds steam pressure. There is a rubber diaphragm *D* held by a pair of flanges; *F* is a piece of 4-inch pipe, smoothly bored; *E* is a ½-inch valve disk; *G* is a water piston; *H* is a 1-inch steam pipe tapped to the under side of the diaphragm *D*; *K* is a ⅜-inch water pipe, with 70 pounds town pressure; *L* is a drip. The piston *G* is held up (and consequently the valve *A* opened) by the town pressure. When a certain steam pressure is realized in the pipe *H*, the diaphragm *D* will raise the valve *E*, by overcoming the water pressure on top of it, and the tension of the spring *M*. The water pressure under the piston *G* will thus be diminished, as the valve *k* is but partly open, and then water goes by valve *E* into the drip *L* faster, or as fast, as the case may be, as the valve *k* will allow it to enter. The piston *G*, being secured to the sheave *O*, will slide down over the stem *N*, and thus close the valve *A*, wholly or in part, depending on how high the valve *E* will rise.

More or less pressure on the low-pressure side of the valve can be obtained by putting more or less tension on the spring *M* by means of the hand-wheel *P*, which connects with a pair of miter gears, the lower loosely secured by means of a long key to a sleeve screwed into guide *R*. A hand-wheel *T* allows the valve *A* to be opened by hand. This valve worked fairly well, after we got the valve *k* properly set.

R. O. RICHARDS.

Framingham, Mass.

Sulphuric Acid Test for Coal

I have seen statements to the effect that a "sulphuric acid test" is resorted to by some engineers to determine the percentage of slate and bone in coal. I presume that solutions of different densities are used to separate the bone coal by flotation, but would like to hear from some of those who have used the method as to the details of the test and its results.

C. G. ARLINGTON.

Philadelphia, Penn.

Gelatinated Oil

I have recently had an experience where a so-called "turbine oil" thickened to about the consistency of "Scott's Emulsion" and had a good deal the same appearance. The engineer in charge of the turbine (I was only erecting it) finds that a heavy engine oil is the better oil to use. I think this is especially the case with the vertical turbine where the oil gets heated very quickly and, unless it has a good body, vibration will result.

W. H. Moore.

Mountain View, N. J.

Our station came near being shut down on account of a new brand of oil which was worthless for turbine use. In this station, oil is used on the step-bearings and they very quickly changed it to jelly of such consistency that it refused to flow to the pumps. By drawing off all the oil every hour and putting in fresh oil, we managed to get along until the right kind of oil arrived by express. On turbines using water on the step-bearings, and oil only on the top and middle bearings, the jelly formation would be much slower. An oil to be successful on step-bearings under high pressure must be capable of mixing, to some extent, with water and disengaging itself from the water in the coolers and filters. Only good mineral oil will work satisfactorily.

I once had trouble with a Lombard water-wheel governor and on disconnecting the oil tank found it nearly half full of a substance as hard as wax. The governor had been in operation several years. I believe the accumulation was paraffin.

A. W. Dow.

Newport, R. I.

A large engine (3500 horse-power) had an oiling system for the main bearings. The shell of the main bearings acted as the bottom oil reservoir, and a small pump, operated from the engine, pumped the oil to an overhead tank, there to flow by gravity to the main bearings, and thence to the bottom reservoir again. The shell of the main bearings was water-jacketed. Some time ago I noticed a jelly which almost floated in the oil. If one were to put his hand in the reservoir and start to agitate the oil, this jelly would rise from the bottom in sheets from 1 to 4 or 5 inches square, and be drawn to the suction pipe of the oil pump and stop it for a minute or so, when it would pump jelly and all to the upper tank.

The bottom of the reservoir was covered with jelly about ½ inch thick. We removed it from time to time. We found most of it on the side where the intake water came in to cool the main bearing and very little where the discharge went out. There was no chance for water to get in with the oil, as was the case in the turbine, except sweat from the cold walls of the water-jacketing. Recently the main bearings were examined and no jelly was found, although conditions are the same.

H. E. Simmons.

Cambridge, Mass.

We are compelled to change and filter the oil from our engine about once a month, because of the thickening of the oil. A month or so after we installed our engine we noticed that the oil failed to feed properly, and on opening the engine filter tank found the bottom covered to a depth of about three inches with a thick slime, while all the oil in the system was somewhat slimy. We emptied this slime, oil and water into a home-made filter, filled the oiling system with new oil and set the old oil aside, taking a jar of it for observation.

After setting a few hours there are two distinct lines of separation shown in the jar; below, a milky water; above the water, a thin jelly-like slime. Above the slime is the oil. We made two simple filters from five-gallon oil cans and empty the oil from the oiling system into them alternately about every month, drawing the oil from the previous month's cleaning from the other filter, and adding new oil to make up the loss. We also draw off the water from below this slime and use the slime to lubricate the gearing of a deep-well pump, for which it answers the purpose indifferently well.

We have no trouble with this slime if we change and filter our oil frequently, but if we neglect our oiling system long the whole body of oil becomes too thick to work.

L. L. Douthat.

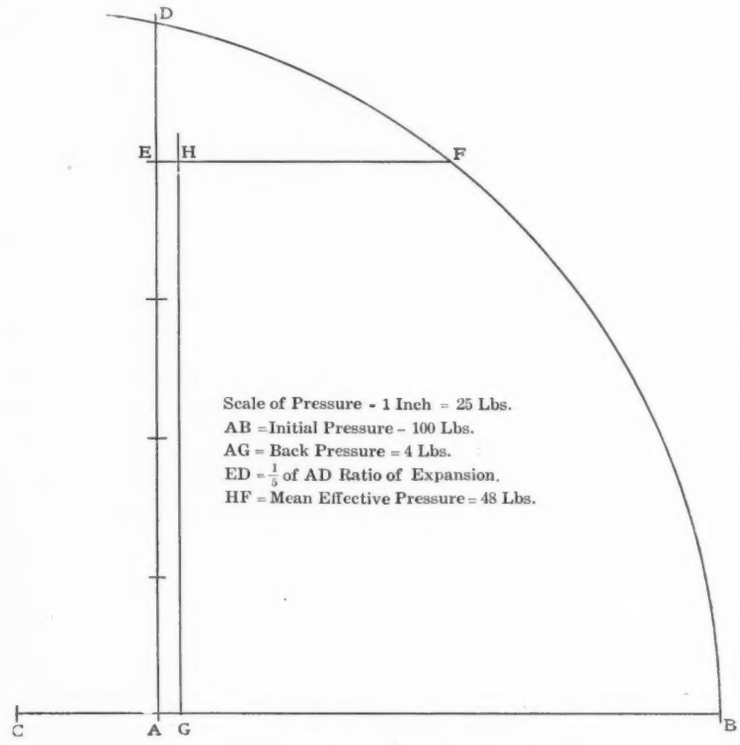
Barboursville, W. V.

To Ascertain Mean Effective Pressure in Cylinders

To obtain the mean effective pressure in a steam-engine cylinder, I have always used the following graphical method, which gives a fairly accurate solution:

Assume a certain scale of pressure, say 25 pounds per square inch, equal to one inch and draw a straight line AB equal to the initial absolute pressure. This is generally taken to be boiler pressure plus 14.7. Extend AB to C and make AC equal to one-fourth of AB. With the point C the center and CB the radius draw the arc BFD. Erect at A a line AD perpendicular to CB, divide the line AD so that the two parts are in the same ratio to each other as the ratio of expansion of the steam. Thus we have DE equal to one-fifth of AD in the case at hand. At E erect a line EF perpendicular to AD. To get the absolute mean effective pressure less the back pressure draw the line GH parallel to AD, the space AG being equal to the back pressure, here assumed at four pounds. By measuring the line HF to the scale of pressure, we ascertain this to be 48 pounds per square inch.

I have used the above method for several years when making new designs for steam-engine cylinders and always found



GRAPHIC SOLUTION FOR MEAN EFFECTIVE PRESSURES

it to be quicker and far easier than calculations.

G. W. AKERLOW.

Brooklyn, N. Y.

[Professor Rankine published this method forty years ago. Mr. Akerlow claims to have worked it out with no knowledge of Rankine's previous demonstration, and has singularly enough hit upon the identical reference letters which Rankine used in his explanation of it in his "Rules and Tables."—EDITORS.]

A Problem in Motor Connection

Herewith is a problem in motor connection. It may look simple, but I once

CONNECTIONS FOR REVERSING MOTOR

saw a consulting engineer spend about two hours figuring it out.

Referring to the sketch, connect the series motor through two double-pole single-throw switches so it can be reversed.

FRANK W. CERNY.

Mesa, Ariz.

Poor Draft

I have just received a copy of the May 26 number, and on page 833 I had the privilege of reading what looks like my own letter on "Poor Draft." It is not very often that an engineer answers his own letters, but that is what I will do in this case. I was always taught that a round stack was the real article for smoke, not an oblong one, nor a square one. The stack in question is an addition of 15 feet added onto the old stack, and I called for a round piece at the time; but the architects who designed the new part of our plant ordered the addition of stack the same shape as the old one, after they had given me their word that it would be round. When the extension arrived I put up a "kick" and tried hard to keep it from going up, but the "man higher up" said: "Let it go; if it does not work, we can change it."

A few weeks ago I asked to have a new piece of at least 5 feet added on, and I said that if it was made round we would have no more trouble, that we would get draft any way the wind blew. But the "man higher up" said he did not know about that, and he did not want to go to any expense until he was convinced. I still claim that if a piece of round stack was on top our draft would be O. K. What do other readers think?

ERNEST MUTCH.

Cambridge, Mass.

A Home Made Ejector

In the plant where I have charge is a 16x9x12-inch underwriter pump that we use for fire purposes, washing out boilers, etc., and also to take the place of the circulating pump when the latter needs repairing. This pump lifts the water about 22 feet, and as it is standing idle a good part of the time, it was sometimes difficult to get it to take the water quickly. As in case of the circulating pump being put out of business, it was necessary to get it to work in a hurry to prevent losing the vacuum, it caused a good bit of anxiety. The writer finally overcame the trouble completely by connecting a home-made ejector to the air chamber on the discharge side, as shown in the sketch.

The ejector is made of a 1-inch tee; the steam pipe is ⅜ inch, and extends past the suction into the discharge pipe 1 inch. When starting up we open the valve *A*, and turn on steam at *B*, which removes

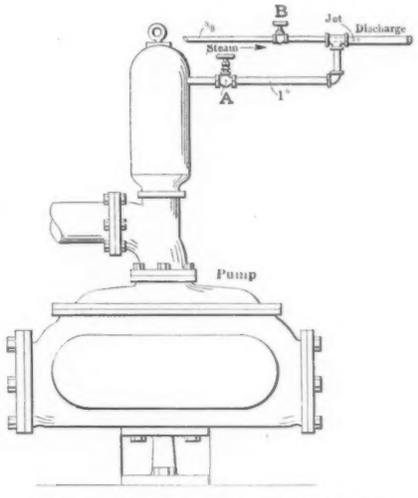


FIG. 1. EJECTOR ON AIR CHAMBER OF PUMP

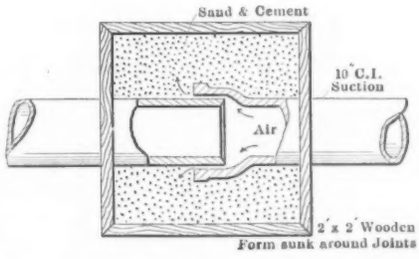


FIG. 2. FORM PLACED AROUND EACH JOINT

the air and forms a vacuum of from 8 to 10 inches in the air chamber. When the pump is started it will immediately pick up the water and go to work. The valves *A* and *B* are then closed.

This pump has a 10-inch cast-iron suction about 30 inches long running to the well.

The pipe has lead joints and gave us lots of trouble by leaking air, and it was necessary to uncover it and calk the joints occasionally. We cured that trouble by making a form about 2 inches square around each joint and filling it with grout made of one part sand and one part portland cement. This was done two years ago and we have had no further trouble from air leaks.

W. GWYNNE.

Springfield, Ohio.

Direct Current Machines Using Carbon Brushes

I have run commutators on direct-current generators and motors for the past four years. The commutators have had nothing but a little mineral oil on them for most of that time. I take out the brushes once a week and clean them; I also clean all the dust from the machines.

I moisten a piece of good, clean, white waste with clean mineral oil, rubbing it in my hands until they are damp with the oil, and hold one hand on the commutator of the generator several times a day. The oil keeps the mica soft; therefore, both brushes wear even. The brushes and commutator are as smooth as glass.

When cleaning up the brushes, if they are rough I take a piece of sandpaper, place it between the commutator and brush and draw it back and forth several times. Any remaining copper on the brush is removed with a sharp knife.

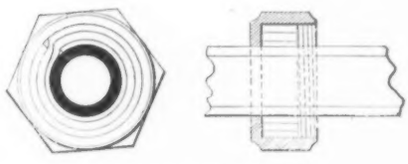
It has been my experience that I did not get the good results from overloaded electrical machinery. Oil containing animal fat is heating and should not be used on commutators. We blow the dust from the machines with 20 pounds of air. I have soaked brushes in mineral oil, but prefer to put the oil on a handful of clean waste and hold it on the commutator when running. I go over the commutators morning and noon, holding the waste back of each set of brushes.

G. M. BARBER.

Talconer, N. Y.

A Gage Glass Packing

When there is no especial packing on hand for gage glasses, or if it is desired



A GAGE-GLASS PACKING

to find a use for scraps of sheet-rubber packing, which would otherwise be thrown away, the following may serve your turn: Cut the sheet-rubber scraps into long pieces, of a width slightly less than the depth of the gland or nut, and wrap the rubber around the glass once or twice, or

as many times as the thickness of the rubber will permit, as shown in the accompanying sketch. Cut the loose end even to match the end in the gland.

The same method may be employed to advantage in packing valve-stems. The sheet rubber should not be too hard, but moderately elastic.

C. WEHMANN.

New Orleans, La.

Useful Formulas for Use in Designing

In all engineering work problems now and then arise which have to deal with numbers slightly above or below unity. While these are easily solved by means of the slide-rule, or by longhand, it is possible to shorten the solution of such problems considerably by the use of simple and easily remembered formulas. While these formulas do not give absolutely correct results, the error in each case is less than would be made with a slide-rule, and for most engineering quantities three places are sufficient, so that for all practical uses the formulas are correct.

The following are the most common of the many formulas which may be derived:

(1) $(1 \pm a)\ (1 \pm b) = 1 \pm a \pm b$;

(2) $(1 \pm a)\ (1 \pm b)\ (1 \pm c) = 1 \pm a \pm b \pm c$;

(3) $(1 + a)\ (1 - a) = 1$;

(4) $(1 \pm a)^n = 1 \pm na$;

(5) $\dfrac{1}{1 \pm a} = 1 \mp a$;

(6) $\dfrac{(1 \pm a)\ (1 \pm b)}{(1 \pm c)} = 1 \pm a \pm b \mp c$;

(7) $\sqrt{1 \pm a} = 1 \pm \dfrac{a}{2}$;

(8) $\sqrt{1 \pm a^2} = 1 \pm \dfrac{a^2}{2}$;

(9) $\dfrac{1}{\sqrt{1 \pm a}} = 1 \mp \dfrac{a}{2}$;

(10) $\dfrac{1}{\sqrt{1 \pm a^2}} = 1 \mp \dfrac{a^2}{2}$;

(11) $\sqrt{1 \pm \dfrac{a^2}{b^2}} = 1 \pm \dfrac{a^2}{2b^2}$;

(12) $\dfrac{1}{\sqrt{1 \pm \dfrac{a^2}{b^2}}} = 1 \mp \dfrac{a^2}{2b^2}$.

In the above formulas a, b and c should not much exceed 0.15 to obtain results accurate enough for engineering use, and the smaller a, b or c is the less will be the error.

Take, for example, the first formula:

$$(1 + a)\ (1 + b) = 1 + a + b.$$

To be absolutely correct it should be:

$$(1 + a)\ (1 + b) = 1 + a + b + ab.$$

In using this formula the error will be that due to the product ab, which will be very small, for if a and b were each 0.1 the product would be 0.01. This would result in the answer by the approximate formula being 1 per cent. lower than the correct answer.

To show the use of the formulas take the following examples:

$1.10 \times 1.08 = 1.18$ from formula (1),

or $1.10 \times 1.08 = 1.188$ exactly. In this example the error would be 0.8 of 1 per cent.

$$1.07 \times 1.12 \times 0.95 = ?$$

Using formula (2):

$$(1 + 0.07)\ (1 + 0.12)\ (1 - 0.05) = 1 + 0.07 + 0.12 - 0.05 = 1.14.$$

The exact answer is 1.1348, so that the approximate answer is in error by less than 0.2 of 1 per cent.

$$\frac{0.96 \times 1.07}{1.08} = ?$$

Using formula (6):

$$\frac{(1 - 0.04)\ (1 + 0.07)}{1 + 0.08} =$$

$$1 - 0.04 + 0.07 - 0.08 = 0.95.$$

The exact answer is 0.9511, so that the error is about 0.1 of 1 per cent.

It will be noted that where numbers are multiplied together where some are less than unity and some greater by nearly the same amount, and where the final answer is near unity, the error is very small. This is also true where numbers greater than unity are divided by numbers also greater than unity, for in both cases the errors tend to balance each other.

To take an example to show where such formulas are of practical use, suppose the horse-power of an engine is in question and it is desired to know what effect the decrease in the mean effective pressure and increase in area and piston speed will result in.

$$H.P. = \frac{PAS}{33{,}000}.$$

Suppose P to decrease 5 per cent., A to increase 4 per cent. and S to increase 6 per cent. Using formula (2):

$$(1 - 0.05)\ (1 + 0.04)\ (1 + 0.06) = 1.05.$$

This shows that the power of the engine would be increased by 5 per cent.; the error in this case is only 0.3 of 1 per cent.

Many uses for these formulas may be found where the saving in time in reaching results will be considerable, and especially will this be true in designing work.

It will, of course, be seen that these formulas also hold for numbers near ten and multiples of ten as well as near unity.

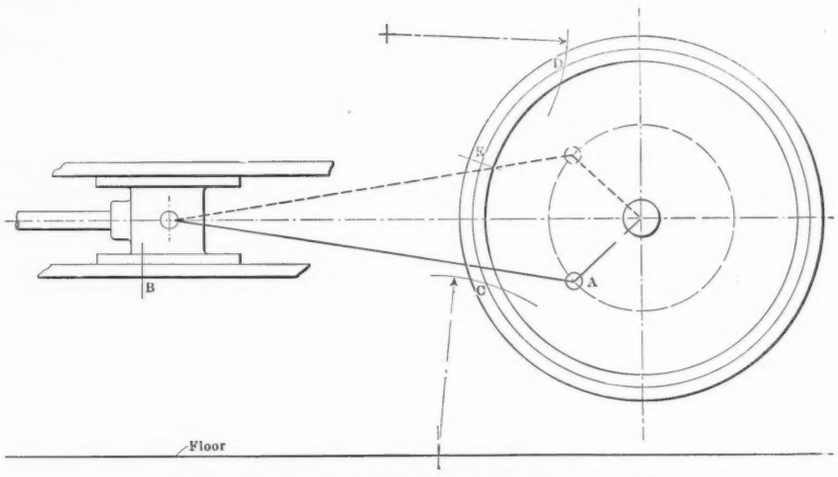
W. L. DURAND.

Brooklyn, N. Y.

Setting an Engine on Dead Center

It is desirable occasionally to set an engine on dead center, accurately. The following is one way of doing this:

1. Turn the fly-wheel in the direction



METHOD OF SETTING AN ENGINE ON DEAD CENTER

in which the engine is to run until the crank is in the position shown at A in the diagram, between 15 and 45 degrees below the horizontal.

2. Make a scratch at B on the side of the crosshead and the engine frame.

3. From a fixed point on the floor strike an arc across the fly-wheel rim. The intersection of this arc with a circle on the rim concentric with the shaft determines the point C.

4. Rotate the fly-wheel slowly in the same direction until the crosshead moves to the end of its stroke and returns to its former position, with the two parts of the scratch exactly in line. The crank is shown dotted in this position. When this the same distance above the horizontal point has been reached, the crank will be as it was below when in position A.

5. From the same fixed point and with the same radius as before, strike another arc on the fly-wheel rim, cutting the same concentric circle, and obtaining the point D. Bi-sect the arc CD, calling its middle point E.

6. Move the fly-wheel in the same direction as before until the point *E* reaches a position such that the same arc, drawn from the same fixed point, passes through it.

This is the position of head-end dead center, a similar method being used to obtain the crank-end dead center.

LUCIEN JONES.

Philadelphia, Penn.

Draining of Steam and Water Pipes

I was very much interested in the article written by H. A. Jahnke, in the May 26 number, on draining steam and water pipes. While I am ready to admit that Mr. Jahnke has given us some valuable information regarding the drainage question, there are points in which I do not agree with him. In the first place, I do not know if he is an agent for some valve manufacturer, but such would seem to be from the profusion of valves he suggests using. This entails quite an item of expense, even though he uses cheap valves—and a cheap make of valve is dear at any price. If a valve leaks it should be repacked at once and not be allowed to continue to leak. If it is one of the flat, composition-disk variety, put in a new disk; if the seat is worn, it can be re-seated with a suitable re-seating tool in a very few minutes, far more quickly than another valve could be substituted, and when you keep adding valves you are simply making more expense and more possibilities of leakage.

Regarding the use of valves in the water-column connection, I am decidedly against any such idea. Most all of our boiler-insurance companies absolutely refuse to allow valves or any obstruction whatever in the water-column connections, and I have witnessed cases of burnt boilers which arose from this same thing, to say nothing of the liability of loss of life from any explosion which might occur from such a source. There are, no doubt, in some localities cases where the column connections might be exposed and might freeze, but of the two evils I believe in choosing the lesser. If a boiler has been run the day previous up to the time of closing down, there is usually a head of steam on when the engine is shut down, and if this is not used in any way it will undoubtedly keep things from freezing. Or, if the case is a desperate one, the column and pipes could be covered with suitable covering to protect them, and I believe that these cases are in the minority, so let us choose the lesser evil and use no valves.

CHARLES H. TAYLOR.

Bridgeport, Conn.

Fahrenheit-Centigrade Temperature Chart

As it is often necessary in many branches of the engineering profession to translate temperatures expressed in the Fahrenheit scale into Centigrade figures, and *vice versa*, the accompanying diagram will prove of value for making these translations rapidly.

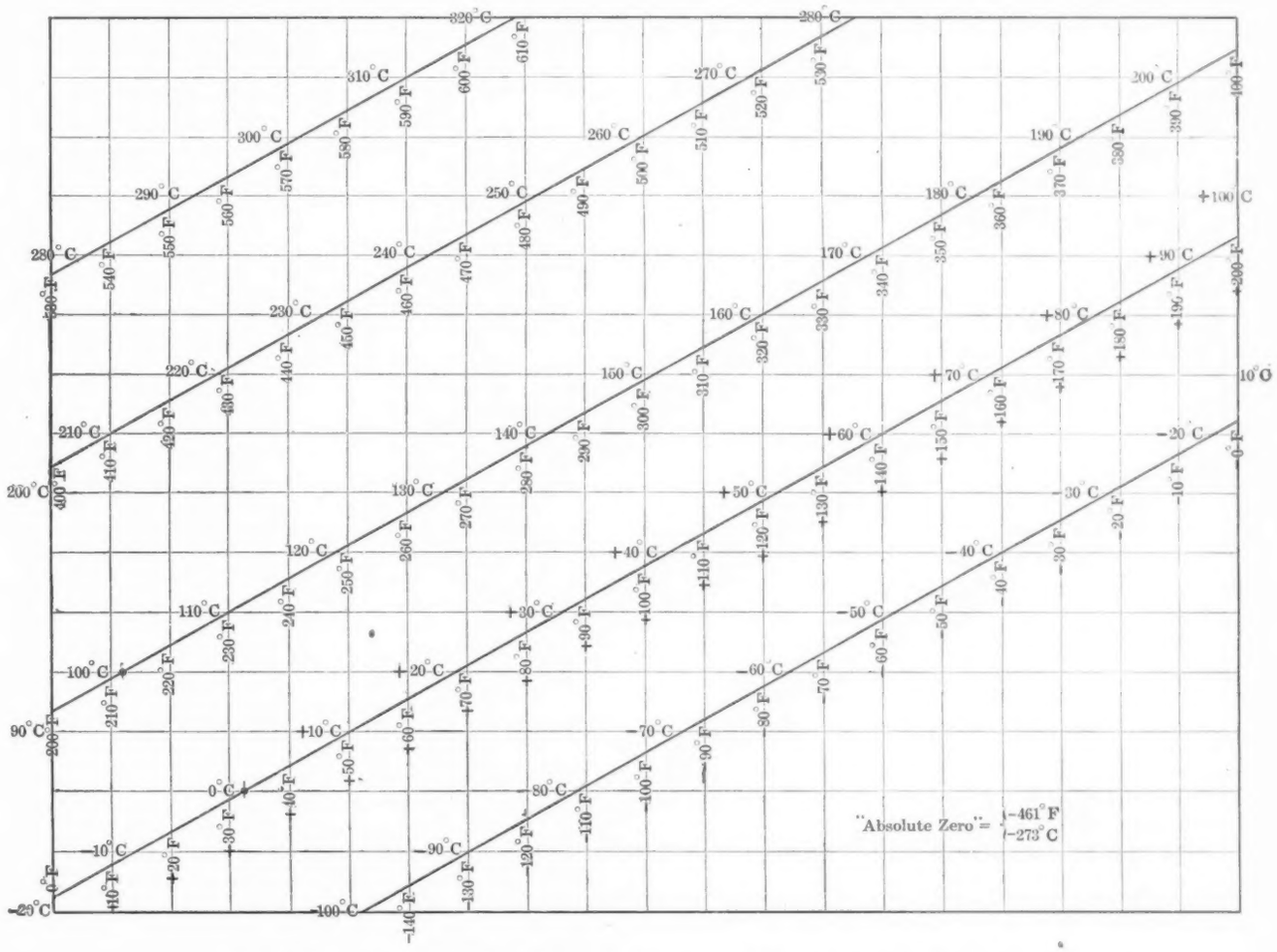
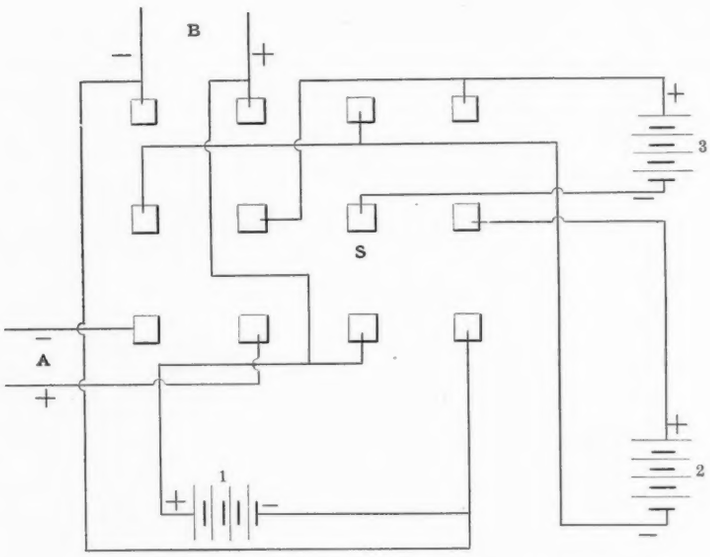


CHART SHOWING COMPARATIVE TEMPERATURES BY FAHRENHEIT AND CENTIGRADE SCALES

Temperatures are plotted from minus 148 degrees Fahrenheit corresponding to minus 100 degrees Centigrade, to plus 608 degrees Fahrenheit corresponding to plus 320 degrees Centigrade, and by this diagram any temperature on either scale may be translated into figures of the other scale with great ease and very considerable accuracy.

S. B. REDFIELD.

New York City.



MR. LINCOLN'S SOLUTION OF PROBLEM IN BATTERY CONNECTIONS

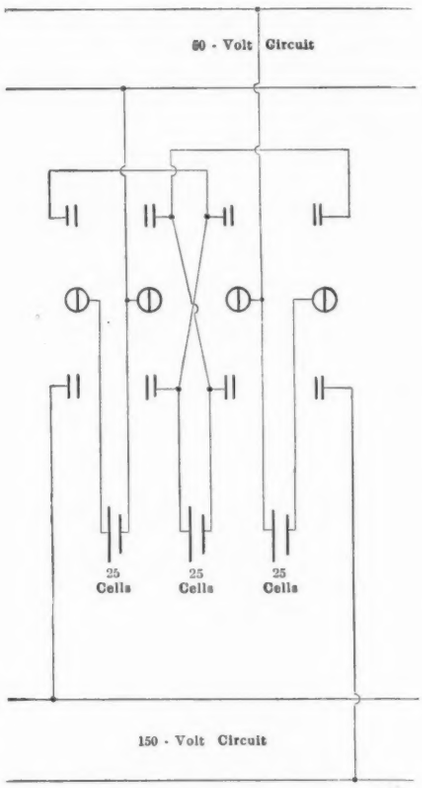
Solution of Problem in Storage Battery Connections

The 150-volt charging circuit is represented at *A* in the accompanying diagram, while the 50-volt lighting circuit is connected at *B*. The storage cells are divided into three sets of 25 each, and are designated by the figures *1*, *2*, *3*. The single switch *S* is of the four-pole double-throw type.

To charge the cells in series the switch is put down, and to discharge the cells in sets of 25, the three sets being in multiple, the switch *S* is thrown up. The lighting circuit is always connected to set *1*, which furnishes current during the charging hours.

E. S. LINCOLN.

Boston, Mass.



MR. MALCOLM'S SOLUTION OF PROBLEM IN STORAGE-BATTERY CONNECTIONS

The accompanying diagram represents my solution of Mr. Lincoln's problem.

THOMAS B. KELLY.

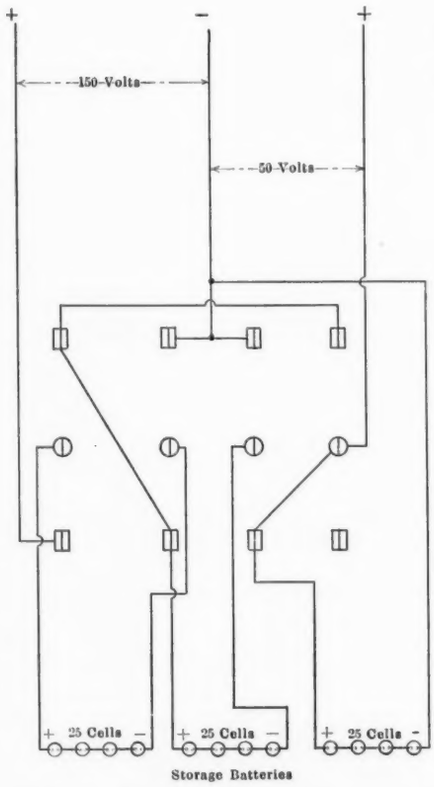
McKeesport, Penn.

Throwing the switch to the upper position puts the cells in series and also gives a 50-volt circuit for the lamps. Throwing the switch to the lower position puts the cells in parallel on the 50-volt circuit.

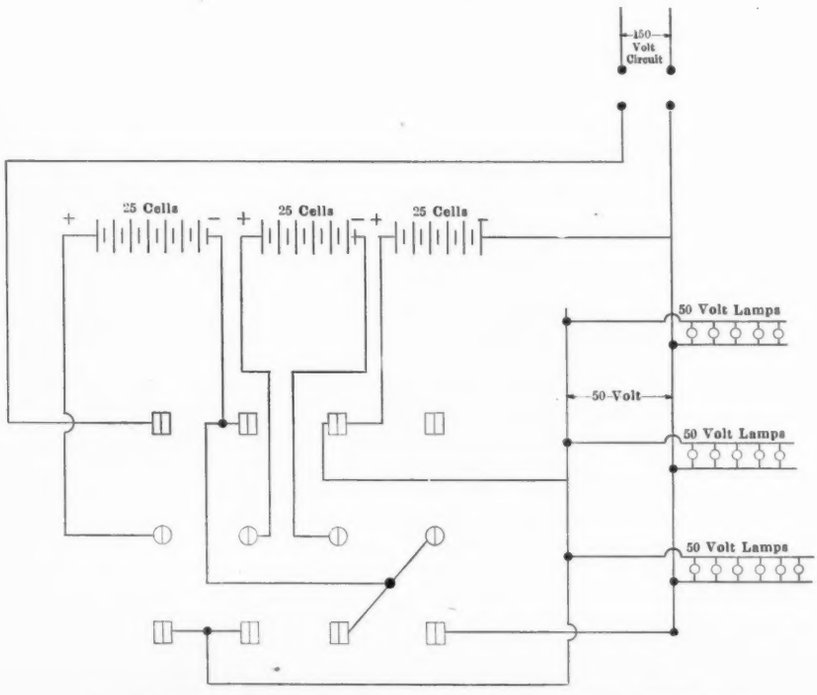
JAMES E. KILROY.

Lincoln Place, Penn.

The accompanying sketch gives a solution of Mr. Lincoln's problem in storage-battery connections. A four-pole double-throw switch is used and the 50-volt cir-



MR. KELLY'S SOLUTION OF PROBLEM IN STORAGE-BATTERY CONNECTIONS



MR. KILROY'S SOLUTION OF PROBLEM IN STORAGE-BATTERY CONNECTIONS

cuit is connected permanently to the inner terminals of the end groups of 25 cells. When the switch is closed upward the cells are all in parallel on the 50-volt circuit; when it is closed downward the cells are all in series on the 150-volt circuit and the 50-volt circuit is supplied from the middle group of 25 cells. With the switch open, the battery is entirely disconnected from the charging circuit and the 50-volt circuit, though connected, receives no current.

GEORGE W. MALCOLM.

Brooklyn, N. Y.

Referring to Mr. Lincoln's problem in storage-battery connections, in the May 5 number, and the solutions published later, I would submit the following: There are many storage batteries used in the fortification works of the United States Coast Defense, and numerous problems such as the one referred to are continually arising. The methods suggested by the various contributors, however, would not be acceptable in the Government service, for the reason that it would require but a small load on the lighting bus-bars during the daily charge to cause deterioration of the section of battery connected continuously in parallel with the lighting load. To charge the battery properly, each section should receive the same amount of current in order that all parts of it may have received a complete charge at the termination of the charging period. If one section receives less current during the entire charge than the other sections, that section will not be properly charged when it is time to discontinue charging other sections.

One of the essential requirements, in order to insure the highest efficiency and longest service from a storage battery, is that it shall be completely and properly charged. If this is not done the elements of the section which has not been fully charged will contain an abnormal amount of acid, causing the plates to deteriorate in proportion to the amount of acid continually remaining in them. A slight difference between one part of the battery and the remainder for a short time (one or two chargings) will not materially affect the elements, but should this difference be continued indefinitely, as it must be in the case under discussion, the result will be a falling off in efficiency of that section which is never fully charged.

The difference in the charge received by the two sections (the 25-cell and the 50-cell sections) of the battery referred to will depend upon the amount of current supplied to the lighting bus-bars during charge; the greater this amount, the greater the difference between the conditions of the two sections. When charging has stopped, either the 50-cell section will be over-charged or the 25-cell section under-charged, according to which of the sections is made the criterion in determining the time to stop charging. Over-charging is not considered as harmful as under-charging, and when done periodically (the period depending upon the amount of service) is a benefit to the battery, but it should not be carried on regularly at every charge period.

If the amount of current supplied the lamps during the day did not exceed 10 per cent. of the total charging current, by judicious regulation of the charge from day to day, as regards over-charging of the 50-cell section and under-charging of the 25-cell section, no great harm would result, but if the section in parallel with the lights, were continuously left under-charged, nothing but harmful results could be expected. I have witnessed a number of times the harmful results caused by continual under-charging.

Another fact which must be considered in this case, and which has apparently been overlooked, is the abnormal rise in voltage during the charging period. As the charge progresses, the charging voltage gradually rises, until at the end of the charge, when the voltage has reached approximately 2.5 volts per cell, the line voltage for charging 75 cells in series must be 190 volts at the very least, and possibly a little more if the internal resistance of the battery is slightly above what it should be. The voltage across the terminals of each 25-cell section of battery would be approximately 63 volts or more, toward the end of the charge, and this would necessarily be the voltage supplied the lights under the conditions presented in the diagrams mentioned; with 50-volt lamps this would be very undesirable owing to the great reduction of their life. However, if only 150 volts are available for charging it would be useless to attempt charging the battery in series.

Unfortunately, Mr. Lincoln does not state the amount of current supplied to the lights or the normal capacity of the battery, which information is necessary to give a proper and intelligent answer to his problem. As Mr. Cheney stated in his letter referring to the problem, to charge the battery in series and discharge its three sections in parallel at the same time, is impossible and out of the question.

RALPH R. GELTZ.

Fort Strong, Mass.

[Mr. Geltz is entirely correct in his discussion of the handling of storage batteries, but he evidently fails to grasp the purpose of these problems, which is to give the reader experience in working out unusual but simple methods of connection, regardless of their engineering merit. The cases are mostly hypothetical, and only their elemental principles are involved, not their operating advisability. In the case under discussion it would have been more practical to take into account the rise of voltage during a charge and the need for equality in the treatment of the different sections, by specifying regulating resistances and means for connecting the lighting circuit to the three sections in rotation, but this would have complicated the problem beyond the reach of the average operating engineer.—EDITORS.]

How Can He Heat the Room?

I am employed in a large building which must be kept warm in the coldest weather. When the weather is very cold we burn a large quantity of coal. The fire-room, which is hot enough in the summer, is the coldest place in the building in very cold weather. This is particularly aggravating at night, when the building is closed. The uptake flue from the ventilating system, which was put in for summer use, becomes an effective means of delivering cold air into the fire-room. To save the small pipes, this flue must be closed. When the flue is closed it becomes a man's work to handle an outside door. There are other indications that the furnace fires require air and lots of it. During the installation of this plant that point was overlooked. I am thinking of making a flue connection from the ash-pits to the outside atmosphere, to be used in cold weather. Before erecting any more sheet-iron monuments to good intentions I would be pleased to hear from someone who (bearing in mind that the fireman must live) has met a like situation and corrected the error.

H. S. THOMAS.

New York City.

Wasting Natural Gas

Having burned natural gas under boilers for several years, and in open-hearth furnaces at the plant where I am employed, the article in the June 2 number, by I. C. White, on the waste of our fuel resources, is of unusual interest.

The fearful waste of natural gas and coal in the United States, besides the great amount being used to convert heat units into power every year, is surely a subject of grave apprehension as to where and when it will end.

Mr. White contends that the time is not far off, but there is another thought I have had in mind for several years, and that is, will not taking so much gas, coal and oil from the earth in time affect the motion of the earth or change its path in its travel around the sun, or change the climate?

There are few people who have lived to be 50 years of age but who can remember when our winters were very different from what they are now, and is it not possible that this old earth may forget to turn over some day, or that we are being drawn nearer the sun each year because the earth is losing some of its buoyancy?

W. D. RANNEY.

Columbus, Ohio.

Calculating the Strength of Riveted Joints

Showing How Anybody Can Calculate the Strength of the Various Types of Joint Used in Boiler Construction, by Simple Arithmetic

BY S. F. JETER

In calculations relative to the strength of steam boilers and vessels of a similar character for withstanding high pressures, one of the most important points to be considered is the strength of the seams where the plates are joined. This is not only important to the designer of such vessels, but also to the operating engineer, who is often required to fix the limit of pressure which should be carried on the boilers under his charge, and frequently, owing to increased output without corresponding addition to the boiler capacity, it becomes necessary to carry the pressure as high as safety will permit, and in such cases it is important for the engineer to be able to fix this safe limit.

It is the purpose of the writer to show how the strength of the various types of joint generally used in boiler construction may be calculated, and as only simple arithmetic is required for the calculations, any of POWER AND THE ENGINEER'S readers should find no difficulty in understanding how it is done, and applying the principles to calculate the strength of the particular joints which may be of interest to them. To avoid the use of formulas, which are confusing to many, numerical examples will be used to illustrate the methods of making the calculations, and for the sake of uniformity the tensile strength of the sheets (which is the strength to resist being pulled apart) will be assumed as 55,000 pounds per square inch; the shearing strength of the rivets (which represents their resistance to being sheared through by the plates at right angles to their length) will be assumed as 42,000 pounds per square inch in single shear, as represented in Fig. 5, and 78,000 pounds per square inch in double shear, as represented in Fig. 8. The resistance of the rivets to crushing will be assumed at 95,000 pounds per square inch. For modern construction consisting of steel plates and steel rivets, the above values are average figures.

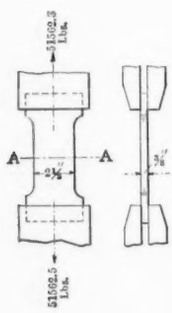


FIG. 1

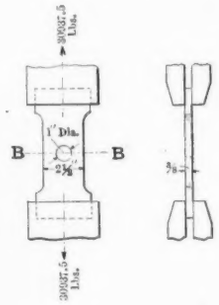


FIG. 2

It is customary to express the strength of a riveted joint as a percentage of the strength of the plates which are riveted together. Thus, if the joint illustrated in Fig. 9 has an efficiency of 62½ per cent., it would mean that any portion of its length that divides the rivet spaces symmetrically, would be 0.625 times as strong as a section of the same length through the solid plate.

POSSIBLE MODES OF FAILURE

Before proceeding to calculate a practical boiler joint, the different ways in which two pieces of plate riveted together might fail should be noted. If a piece of boiler plate, ⅜ inch thick and 2½ inches wide, is placed in the jaws of a testing machine, as illustrated in Fig. 1, and pulled apart, it would separate at some section as *A A*. If the tensile strength was 55,000 pounds per square inch, the force that would have to be applied to the jaws would be 55,000 times the area separated in square inches, which in this case is

$$2\frac{1}{2} \times \frac{3}{8} = 15/16 = 0.9375$$

square inch, so that the pull would be

$$55{,}000 \times 0.9375 = 51{,}562.5$$

pounds.

If another piece of plate be taken, identical in every respect to the first, except that a hole 1 inch in diameter is drilled through it as illustrated in Fig. 2, and the plate be pulled apart in the testing machine as before, it is evident that it would fail along the line *B B*, as the area of the reduced section caused by drilling the hole would be only

$$(2.5 - 1) \times 0.375 = 0.5625$$

square inch, and the force necessary to pull it apart would be

$$55{,}000 \times 0.5625 = 30{,}937.5$$

pounds, the strength of the metal being the same in both instances. Now if the relation between the strength of the solid plate and the drilled plate be expressed by dividing the latter by the former, the result would be

$$\frac{30{,}937.5}{51{,}562\ 5} = 0.6,$$

or, in other words, the drilled plate is capable of sustaining 60 per cent. of the load that could be carried by the solid plate.

If, instead of using a single piece of plate, two plates are drilled with 1-inch holes in the ends and are joined together by a rivet, as shown in Fig. 3, and an attempt should be made to pull them apart as before, there would be four probable ways in which failure might take place, all of which are considered in the calculation and design of riveted joints. First, the section of plate each side of the rivet hole might break, leaving the ends as shown in Fig. 4. Again, the plates might shear the rivets off, as illustrated in Fig. 5. Thirdly, it has been found by practical tests of joints that steel rivets cannot be subjected to a pressure much greater than 95,000 pounds per square inch of bearing surface without materially affecting their power to resist shearing, and therefore the joint might fail, as shown in Fig. 5, due to an excess crushing stress on the rivet. A fourth possible method of failure would be for the metal in the sheet in front of the rivet to split apart or pull out, as illustrated in Fig. 6. This latter mode of failure is erratic, and cannot be calculated, but it has been practically demonstrated in tests of joints, that if the distance from the edge of the plate to the center of the rivet hole is 1½ times the diameter of the hole, this mode of failure is improbable, and in the following calculations of joints it will be assumed that they are properly designed to render such failure impossible.

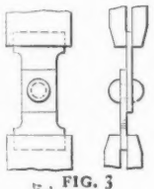


FIG. 3

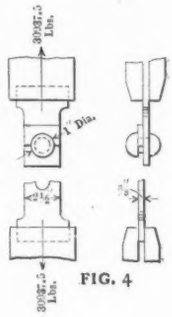


FIG. 4

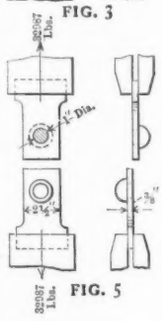


FIG. 5

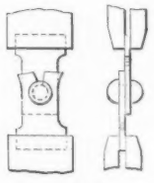


FIG. 6

To determine the actual strength or efficiency of such a joint as is illustrated in Fig. 3, the force required to produce

rupture must be calculated for each of the first three ways mentioned, and the weakest mode of failure taken as the maximum strength of the joint.

To rupture the plate as illustrated in Fig. 4, the pull required would be the same as to rupture the drilled plate illustrated in Fig. 2, which was found to be 30,937.5 pounds. To shear the rivet off as in Fig. 5 would require a force equal to the area to be sheared in square inches, times the shearing strength per square

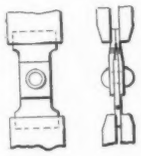


FIG. 7

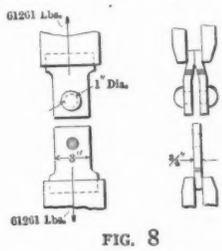


FIG. 8

inch; or since the area of a 1-inch rivet is 0.7854 square inch, the force required would be

$$0.7854 \times 42{,}000 = 32{,}987$$

pounds. The pressure required to cause failure by crushing was stated to be 95,000 pounds per square inch, and in calculating the area exposed to pressure for pins and rivets, it is figured as equal to the diameter of the pin or rivet, times the thickness of the plate; therefore, we have

$$1 \times 0.375 = 0.375$$

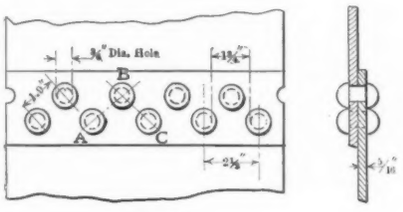


FIG. 10

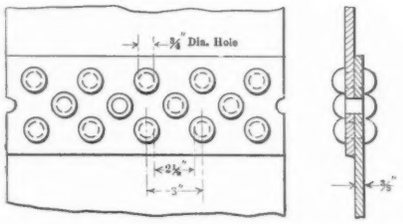


FIG. 11

square inch of area to withstand crushing, or

$$0.375 \times 95{,}000 = 35{,}625$$

pounds would be required to produce rupture of the joint in this manner.

From these figures it is evident that the method of failure first considered is the weakest of the three, and, therefore, determines the efficiency of the joint, which would be 60 per cent. as found for the drilled plate.

If one plate is riveted between two other plates, as illustrated in Fig. 7, the several methods of failure are calculated in the same way, except for the shearing of the rivet, which would occur as shown in Fig. 8 and is described as double shearing. While the metal sheared in this case would be just twice as much as in single shear, it has been found by test that the force required is not exactly twice as much, but 1.85 to 1.90 times the amount in single shear; so as stated at the beginning, 78,000 pounds per square inch is assumed for rivets in double shear and 42,000 pounds per square inch when in single shear.

Calculating the strength of a joint with the dimensions as illustrated in Fig. 8, the strength of the solid plate would be

$$3 \times 0.75 \times 55{,}000 = 123{,}750$$

pounds. The strength of the center plate through the rivet hole, the failure being assumed similar to that illustrated in Fig. 4, would be

$$(3 - 1) \times 0.75 \times 55{,}000 = 82{,}500$$

pounds. The crushing strength of the rivet would be

$$1 \times 0.75 \times 95{,}000 = 71{,}250$$

pounds. The shearing strength of the rivet, or failure assumed as in Fig. 8, would be

$$0.7854 \times 78{,}000 = 61{,}261$$

pounds.

From these figures it is evident that failure would most likely occur as shown

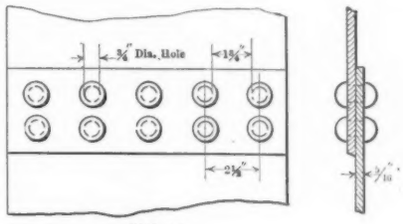


FIG. 12

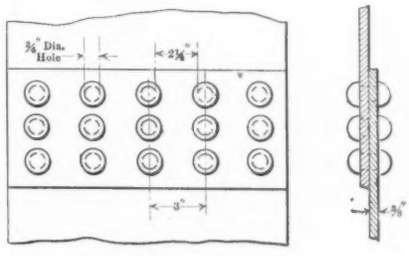


FIG. 13

in Fig. 8, and the relative strength of the joint as compared with the solid plate is

$$\frac{61{,}261}{123{,}750} = 0.495,$$

or 49½ per cent. As will be shown later, the foregoing simple calculations are all that are required to estimate the strength of the most complicated joints.

The Unit Section

In calculating the strength of a practical boiler joint, the strength for the entire length of a sheet could be estimated, but this would be laborious owing to the number of figures involved in the calculations, and the same result can be obtained by considering any length that divides the rivets symmetrically. For convenience, the shortest length that thus divides the rivets is the one used in such calculations, and this length is called a unit section of the joint. When the lines dividing the joint into unit sections pass through a

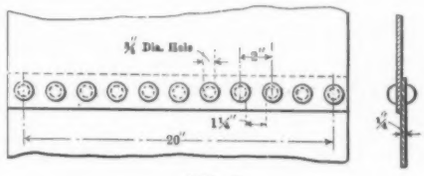


FIG. 9

rivet, only one-half of the rivet is considered in the calculation, and when rivets thus divided are lettered for reference, the two halves on opposite sides will be lettered the same, so that referring to the letter will indicate a whole rivet. Thus, if the rivet *A*, in Fig. 17, is spoken of, it would mean the combined halves of the two rivets on the outer row.

In measuring joints already constructed to obtain the length of a unit section, or the pitch, it should be remembered that rivet heads do not always drive fairly over the center of the rivet holes, and the rivet holes themselves are sometimes irregular distances apart; so it is more accurate to measure a number of pitches and divide the distance by the number measured to obtain the average pitch. It will be found most convenient, where space permits, to measure ten pitches, and then placing the decimal point one figure to the left will give the average unit length.

Single-riveted Lap-joint

First to be considered is the single-riveted lap-joint illustrated in Fig. 9. In a unit section of 2 inches one rivet is in single shear and ¾ inch has been cut out of the plate by the rivet hole. The calculation for strength is the same as has been made for Fig. 4, and the three methods of failure to be considered are:

(1) Breaking of the section of plate between the rivet holes, which is called the net section.

(2) Shearing of a ¾-inch rivet in single shear.

(3) Resistance of one rivet to crushing.

Using the numerical values given in Fig. 9 the following results are obtained:

(1) $(2 - 0.75) \times 0.25 \times 55{,}000 =$ 17,187.5 pounds.

(2) $0.4418 \times 42{,}000 =$ 18,556 pounds.

(3) $0.75 \times 0.25 \times 95{,}000 =$ 17,812.5 pounds.

Of the three methods of failure, the first is seen to be the most probable, and

since a unit section length of the solid plate would have a strength of

$$2 \times 0.25 \times 55{,}000 = 27{,}500$$

pounds, the efficiency of the joint would be

$$\frac{17{,}187.5}{27{,}500} = 62.5$$

per cent.

DOUBLE-RIVETED LAP-JOINT

Next in line is the double-riveted lap-

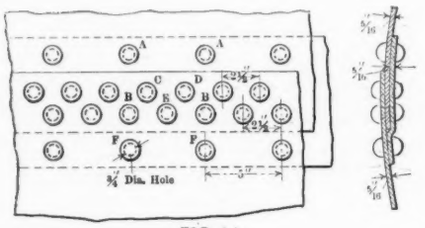


FIG. 14

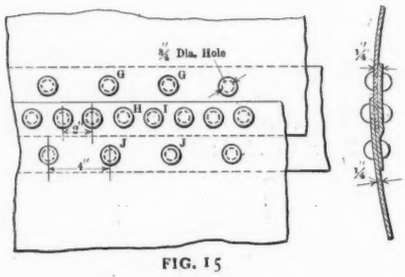


FIG. 15

joint illustrated in Fig. 10. There is one feature connected with this joint which should be considered before proceeding with the calculation of its strength. It would evidently be possible to have the two rows of rivets forming this joint so close together that the combined net sections between rivets *A B* and *B C* would be less than between rivets *A C*. It has been found in practical tests of joints that it is necessary to have the combined area of these two sections 30 to 35 per cent. in excess of that between rivets *A* and *C* in order to be sure that the joint will fail along line *A C*. This would correspond to a diagonal pitch of two-thirds of the pitch from *A* to *C* plus one-third of the diameter of the rivet hole, or 1.9 inches in the joint shown in Fig. 10. Ordinarily, if the rows are much closer than this, the joint has an abnormal appearance which would be noted at once. In further calculations it will be assumed that the joints are proportioned so that this method of failure will not be possible.

Proceeding with the calculation of the strength of the joint illustrated in Fig. 10, the methods of probable failure to be calculated are the same as for the single-riveted joint:

(1) Failure of net section between rivet holes.

(2) Shearing of two rivets in single shear.

(3) Crushing strain on two rivets.

Using the values given in Fig. 10, we have for the above:

(1) $(2.5 - 0.75) \times 0.3125 \times 55{,}000 =$ 30,078 pounds.

(2) $2 \times 0.4418 \times 42{,}000 =$ 37,112 pounds.

(3) $2 \times 0.75 \times 0.3125 \times 95{,}000 =$ 44,531 pounds.

It is evident that the first method of failure is the most probable, and since the strength of the solid plate is

$$2.5 \times 0.3125 \times 55{,}000 = 42{,}969$$

pounds, the efficiency of the joint will be

$$\frac{30{,}078}{42{,}969} = 70$$

per cent.

TRIPLE-RIVETED LAP-JOINT

In Fig. 11 is illustrated a triple-riveted lap-joint. Here the length of unit section is 3 inches, and the different probable modes of failure are identical with those of the single- and double-riveted lap-joints except in rivet strength. It will be noted that in this case there are three rivets contained in each unit section, which are subjected to shear and crushing. The several methods of probable failure to be investigated are as follows:

(1) Failure of net section between the rivet holes of outer rows.

(2) Shearing of three rivets in single shear.

(3) Crushing strain on three rivets.

Using the numerical values specified in Fig. 11, we would have:

(1) $(3 - 0.75) \times 0.375 \times 55{,}000 =$ 46,406 pounds.

(2) $3 \times 0.4418 \times 42{,}000 =$ 55,667 pounds.

(3) $3 \times 0.75 \times 0.375 \times 95{,}000 =$ 80,156 pounds.

The first method of failure assumed is

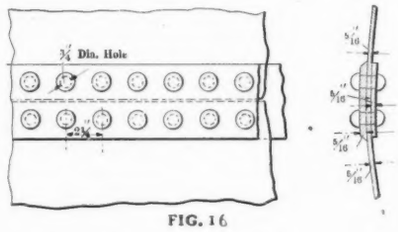


FIG. 16

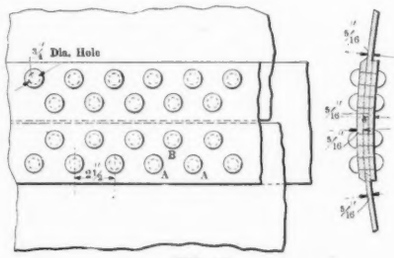


FIG. 17

the most likely, and as the strength of the solid plate for a unit section of length is

$$3 \times 0.375 \times 55{,}000 = 61{,}875$$

pounds, the efficiency of joint is

$$\frac{46{,}406}{61{,}875} = 75$$

per cent. The triple-riveted joint represents about the maximum strength that can be obtained in practice from simple lap-riveted joints, as in this form the maximum pitch distance that permits proper calking of the edge of the plates is reached, and still leaving the net section of metal between the rivet holes the weakest portion of the joint, so that further addition of rivets would not add to its strength.

CHAIN RIVETING

Joints illustrated in Figs. 10 and 11 have

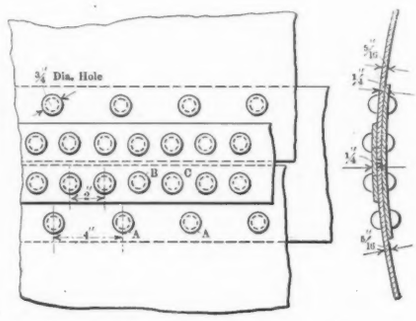


FIG. 18

the rivets arranged so that the rivets in one row come opposite the spaces in the adjacent rows, and this arrangement is termed staggered riveting. The same forms of joint are sometimes made with the rivets placed in straight rows across the joint, as illustrated in Figs. 12 and 13, which is known as chain riveting. The calculations for joint efficiency in chain-riveted joints are identical in every respect to those for staggered riveting, and with equal diameters and spacing of rivets and equal thicknesses of plate, the efficiencies are the same for either type.

LAP-RIVETED JOINT WITH INSIDE STRAP

While the lap-riveted joint with inside strap is not extensively used in the manufacture of new boilers, it affords a ready means of strengthening simple lap seams on boilers already constructed, and it is quite extensively used for this purpose. This joint is illustrated in Figs. 14 and 15, and it will be seen that it is equally applicable to single- or double-riveted lap-joints; it could also be applied to triple-riveted joints. The joint illustrated in Fig. 14 is identical in every respect with the one shown in Fig. 10, excepting the addition of the 5/16-inch cover strip and the outer rows of rivets, these dimensions being selected to facilitate comparison between the strengths of the two joints. A unit section of this joint is 5 inches long, and five methods of failure present themselves for consideration in determining the strength of the joint:

(1) Breaking of the plate along the section between the rivet holes *A A*.

(2) The separation of the plate along the section on line of rivets *C D* and shearing the rivet *A*.

(3) Separation of the plate along the section on line of rivets *C D* and the crushing of rivet *A*.

(4) Crushing of rivets *A B C D E* by the shell.

(5) Shearing of rivets *B C D E F* in single shear.

The pulling out of the upper plate, which would shear rivet *A* single, and *B C D E* double, need not be considered, since it would evidently be stronger than the fifth method considered above. Calculating the value of the possible methods of failure by using the dimensions given in Fig. 14, we have:

(1) $(5 - 0.75) \times 0.3125 \times 55{,}000 =$ 73,040 pounds.

(2) $[5 - (2 \times 0.75)] \times 0.3125 \times 55{,}000 + 0.4418 \times 42{,}000 =$ 78,726 pounds.

(3) $[5 - (2 \times 0.75)] \times 0.3125 \times 55{,}000 + 0.3125 \times 0.75 \times 95{,}000 =$ 82,436 pounds.

(4) $0.3125 \times 0.75 \times 95{,}000 \times 5 =$ 111,330 pounds.

(5) $0.4418 \times 42{,}000 \times 5 =$ 92,780 pounds.

Evidently the net section between the rivet holes *A A* is the weakest portion of the joint, and since a section of the solid plate 5 inches long has a strength of

$$5 \times 0.3125 \times 55{,}000 = 85{,}937$$

pounds, the efficiency of the joint is

$$\frac{73{,}040}{85{,}937} = 85$$

per cent.

Calculation of the joint illustrated in Fig. 15 is proceeded with in the same manner as for Fig. 14. It will be noted that to aid comparison the dimensions have been assumed the same as in Fig. 9 with the strap added. The methods of possible failure to be compared are:

(1) Separation of the plate along net section *G G*.

(2) Separation of plate along section *H I* and shearing of rivet *G* in single shear.

(3) Separation of plate along section *H I* and crushing of rivet *G*.

(4) Crushing of rivets *G, H, I*.

(5) Shearing of rivets *H, I, J* in single shear.

According to the dimensions given in Fig. 15 the numerical values would give the following results.

(1) $(4 - 0.75) \times 0.25 \times 55{,}000 =$ 44,687 pounds.

(2) $[4 - (2 \times 0.75)] \times 0.25 \times 55{,}000 + 0.4418 \times 42{,}000 =$ 52,931 pounds.

(3) $[4 - (2 \times 0.75)] \times 0.25 \times 55{,}000 + 0.75 \times 0.25 \times 95{,}000 =$ 51,187 pounds.

(4) $0.75 \times 0.25 \times 95{,}000 \times 3 =$ 53,436 pounds.

(5) $0.4418 \times 42{,}000 \times 3 =$ 55,668 pounds.

Since the strength of the solid plate is

$$4 \times 0.25 \times 55{,}000 = 55{,}000$$

pounds, the efficiency would be

$$\frac{44{,}687}{55{,}000} = 81.25$$

per cent.

It is thus apparent that by adding a strap to the joint illustrated in Fig. 9 and making it like Fig. 15, the efficiency has been increased from 62.5 per cent. to 81.25 per cent., which would permit an increase in steam pressure of 30 per cent. on the boiler after such change.

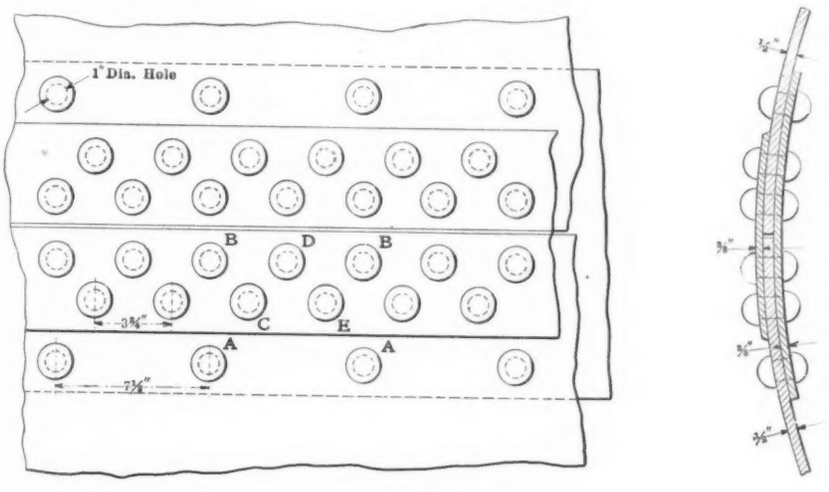


FIG. 13

Single-riveted Double-strapped Butt-joint

In describing all forms of butt-joints it is customary to refer to the rivets on one side of the butt only; thus, in Fig. 16 there are actually two rows of rivets, but the joint is only single-riveted, for the strength of the joint along either row is in no wise dependent on the other row. If the two rows should not be riveted alike, it would be necessary to consider each side as a separate joint to find which was the weaker in order to determine the strength of the combination. This, however, is not necessary in practical boiler joints, since they are constructed alike on each side of the butt.

In the joint illustrated in Fig. 16 it will be noted that all of the rivets are in double shear, and only three methods of possible failure are presented for calculation:

(1) Breaking of the net section.

(2) Shearing of one rivet in double shear.

(3) Crushing of a rivet by the shell.

With the dimensions given in the figure we have:

(1) $(2.25 - 0.75) \times 0.3125 \times 55{,}000 =$ 25,781 pounds.

(2) $0.4418 \times 78{,}000 =$ 34,460 pounds.

(3) $0.75 \times 0.3125 \times 95{,}000 =$ 22,230 pounds.

The strength of the solid plate is

$$2.25 \times 0.3125 \times 55{,}000 = 38{,}672$$

pounds, and since the weakest portion of the joint is the resistance to crushing of the rivets, the efficiency is

$$\frac{22{,}230}{38{,}672} = 57.5$$

per cent.

Double-riveted Double-strapped Butt-joint

Double-riveted butt-joints can be made in two forms, the one generally used being illustrated in Fig. 17. The calculations for the efficiency of this joint are the same as for the single-riveted joint, except that there are two rivets to be considered in each unit section of the joint instead of one. The three methods of possible failure are:

(1) Pulling apart of the sheet along net section *A A*.

(2) Shearing of rivets *A, B* in double shear.

(3) Crushing of rivets *A, B*.

Substituting the values given in Fig. 17, we have:

(1) $(2.5 - 0.75) \times 0.3125 \times 55{,}000 =$ 29,085 pounds.

(2) $0.4418 \times 78{,}000 \times 2 =$ 68,920 pounds.

(3) $0.75 \times 0.3125 \times 95{,}000 \times 2 =$ 44,532 pounds.

The strength of the solid plate is

$$2.5 \times 0.3125 \times 55{,}000 = 42{,}969$$

pounds, and the weakest portion of the joint is the net section between rivets *A, A*. Therefore, the efficiency is

$$\frac{29{,}085}{42{,}969} = 67.6$$

per cent.

In Fig. 18 is illustrated the second type of double-riveted butt-joint. This form of joint, if proportioned properly, can be made considerably stronger than the one illustrated in Fig. 17. There are six methods of possible failure to be considered:

(1) Pulling apart of the sheet along net section *A A*.

(2) Pulling apart of the sheet along section *B C* and shearing rivet *A*.

(3) Pulling apart of sheet along section *B C* and crushing of rivet *A*. (Note that in calculating the crushing of rivet *A* the thickness of the strap is to be used instead of the plate, owing to the strap being thinner than the plate.)

(4) Shearing of rivet A single and B, C double shear.

(5) Crushing of rivets B, C in the plate and A in the strap.

(6) Crushing of rivets B, C in the plate and shearing of rivet A.

Substituting the numerical values from Fig. 18, we have:

(1) $(4 - 0.75) \times 0.3125 \times 55{,}000 = 55{,}859$ pounds.

(2) $[(4 - 1.5) \times 0.3125 \times 55{,}000] + (42{,}000 \times 0.4418) = 61{,}525$ pounds.

(3) $[(4 - 1.5) \times 0.3125 \times 55{,}000] + (0.75 \times 0.25 \times 95{,}000) = 60{,}781$ pounds.

(4) $(42{,}000 \times 0.4418) + (78{,}000 \times 0.4418 \times 2) = 87{,}476$ pounds.

(5) $(0.75 \times 0.3125 \times 95{,}000 \times 2) + (0.75 \times 0.25 \times 95{,}000 = 62{,}272$ pounds.

(6) $(0.75 \times 0.3125 \times 95{,}000 \times 2) + (42{,}000 \times 0.4418) = 63{,}087.25$ pounds.

From these figures it will be seen that the net section between the rivet holes A, A is the one most likely to fail, and since the strength of a unit section of the solid plate is

$$4 \times 0.3125 \times 55{,}000 = 68{,}750$$

pounds, the efficiency of the joint is

$$\frac{55{,}859}{68{,}750} = 81.25$$

per cent.

Triple-riveted Double-strapped Butt-joint

The joint illustrated in Fig. 19 is known as the triple-riveted butt-joint. The methods of failure to be investigated are the same as those in Fig. 18, and are as follows:

(1) Pulling apart of sheet at net section $A\,A$.

(2) Pulling apart of sheet along section $C\,E$ and shearing rivet A.

(3) Pulling apart of sheet along section $C\,E$ and crushing rivet A.

(4) Shearing rivet A single and B, C, D, E double.

(5) Crushing of rivets B, C, D, E in the plate and A in the strap.

(6) Crushing of rivets B, C, D, E in the plate and shearing of rivet A.

Substituting the values given in Fig. 19,

(1) $(7.5 - 1) \times 0.5 \times 55{,}000 = 178{,}750$ pounds.

(2) $[(7.5 - 2) \times 0.5 \times 55{,}000] + (42{,}000 \times 0.7854) = 184{,}237$ pounds.

(3) $[(7.5 - 2) \times 0.5 \times 55{,}000] + (1 \times 0.5 \times 95{,}000 = 198{,}250$ pounds.

(4) $0.7854 \times 42{,}000) + (0.7854 \times 78{,}000 \times 4) = 278{,}027$ pounds.

(5) $(1 \times 0.5 \times 95{,}000 \times 4) + (1 \times 0.375 \times 95{,}000) = 225{,}625$ pounds.

(6) $(1 \times 0.5 \times 95{,}000 \times 4) + (0.7854 \times 42{,}000) = 222{,}987$ pounds.

For a unit length the strength of the solid plate is

$$7.5 \times 0.5 \times 55{,}000 = 206{,}250$$

pounds. The net section between rivets A, A is the weakest portion of the joint, so that the efficiency is

$$\frac{178{,}750}{206{,}250} = 86.7$$

per cent.

Quadruple-riveted Double-strapped Butt-joint

The last type of joint to be considered is the quadruple-riveted butt-joint illustrated in Fig. 20. This joint is now used on nearly all high-grade boilers of the horizontal return-tubular type, and it marks about the practical limit of efficiency for riveted joints connecting plates of uniform thickness together. The methods of failure to be considered are practically the same as in the two preceding joints, except that there are more rivets concerned in the calculations:

(1) Pulling apart of the sheets along net section $A\,A$.

(2) Pulling apart of the sheet along section $D\,E\,F\,G$ and shearing rivets A, B, C.

(3) Pulling apart of sheet along section $D\,E\,F\,G$ and crushing of rivets A, B, C in the strap.

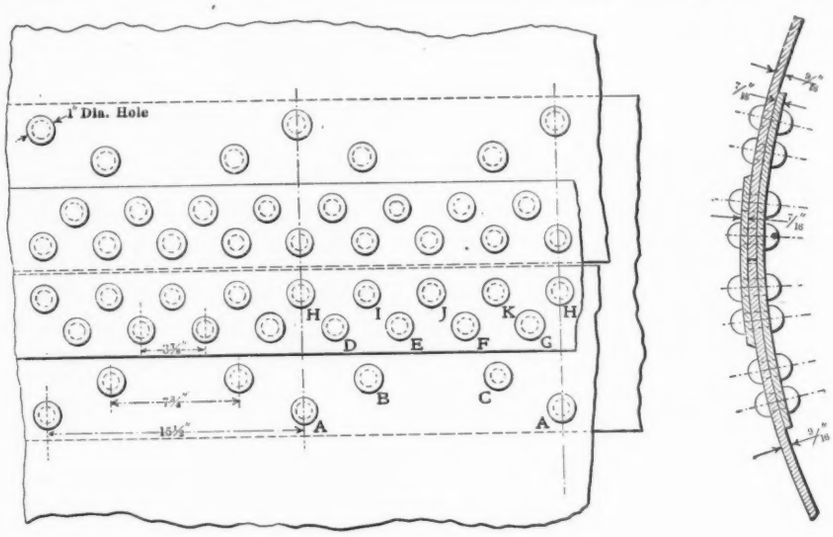


FIG. 20

(4) Shearing rivets A, B, C in single shear and D, E, F, G, H, I, J, K in double shear.

(5) Crushing of rivets D, E, F, G, H, I, J, K in plate and A, B, C in the strap.

(6) Crushing of rivets D, E, F, G, H, I, J, K in the plate and shearing rivets A, B, C.

Using the numerical values of Fig. 20, we have:

(1) $(15.5 - 1) \times 0.5625 \times 55{,}000 = 448{,}580$ pounds.

(2) $[(15.5 - 4) \times 0.5625 \times 55{,}000] + (3 \times 42{,}000 \times 0.7854) = 454{,}739$ pounds.

(3) $[(15.5 - 4) \times 0.5625 \times 55{,}000] + (3 \times 0.4375 \times 1 \times 95{,}000) = 480{,}465$ pounds.

(4) $(3 \times 42{,}000 \times 0.7854) + (8 \times 78{,}000 \times 0.7854) = 589{,}050$ pounds.

(5) $(8 \times 0.5625 \times 1 \times 95{,}000) + (3 \times 0.4375 \times 1 \times 95{,}000) = 552{,}187$ pounds.

(6) $(8 \times 0.5625 \times 1 \times 95{,}000) + (3 \times 42{,}000 \times 0.7854 = 526{,}461$ pounds.

The strength of the solid plate is

$$15.5 \times 0.5625 \times 55{,}000 = 479{,}528$$

pounds, and the failure of the sheet by pulling apart along the net section $A\,A$ is the one that determines the efficiency of the joint, which is

$$\frac{448{,}580}{479{,}528} = 93.55$$

per cent.

From the foregoing calculations it may be observed that estimating the efficiency of riveted joints, while very simple, is a rather tedious process, particularly if many joints are to be calculated. It is proposed to show in a subsequent article how most of the labor involved may be dispensed with, and in this connection it may be pointed out that if the net section between the rivet holes of the outer row of rivets is the weakest portion of a joint, the efficiency may be obtained direct, without reference to the tensile strength of the plate or the shearing strength of the rivets, by dividing the length of the net section by the unit length, or pitch. Thus, for the efficiency of the joint illustrated in Fig. 19, we would have

$$\frac{7.5 - 1}{7.5} = 86.7$$

per cent. for joints similar to Figs. 19 and 20 and for plate thicknesses usually found in horizontal tubular boilers, this method of obtaining the efficiency will be approximately correct, and at most will not be off more than a few per cent.

Never start to take a piston out of a cylinder without being certain that the throttle and exhaust valves are both shut tight and the drains wide open. Also try the indicator cocks to see whether there is any pressure. A neglect of these precautions was the cause of a funeral in Lowell, Mass., a short time ago.

The effect of angularity of the connecting rod is to make the cutoff later on the head end than on the crank end. The shorter the rod the greater the difference.

Accident to an Engine at Birkenhead, England

By A. E. Griffiths

On May 12, at the Birkenhead (England) Corporation's South End generating station, an accident occurred to a high-speed vertical 11¼x21x10-inch cross-com-

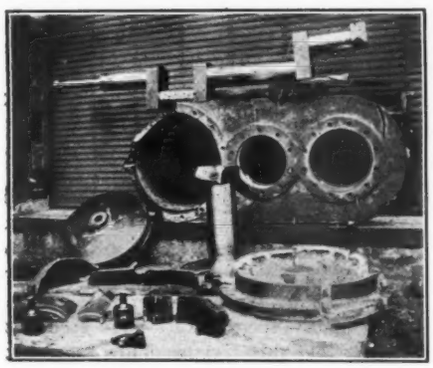


FIG. 1. PARTS OF BIRKENHEAD ENGINE WRECK

pound engine direct-coupled to a 150-kilowatt generator, and run at a speed of 360 revolutions per minute. A banging was heard in the engine and the engineer ran to shut it down. Just as he was nearing it, the false head on the low-pressure cylinder flew up and dropped at his side. He changed his course and shut down from the boiler house. Before he had done so, the low-pressure cylinder cover cracked, one piece dropping on one side of the engine, another on the other side, and a third flew over the generator and,

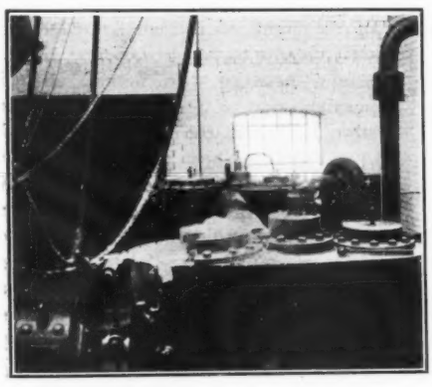


FIG. 2. THE CYLINDERS OF THE WRECKED ENGINE

grazing the brush arm, dropped into the pit below.

On opening out to find the cause it was seen that the low-pressure crank web and two bearing caps had broken, and the trunk and bed were badly cracked, the crack in the bed extending from one side of the engine underneath the bearing next to the fly-wheel, and out at the other side. On a further examination it was found that the governor balls had also broken off.

The accident was at first put down to the governor failing, but it is now attributed to the crank web breaking first, for on placing the parts of the broken governor together, it was seen that the governor arms had been bent considerably before breaking, due to the sudden jerk resulting when one part of the broken web jamming on top of the other part forced the piston against the cover.

The accompanying views show some of the broken parts. In Fig. 1 it will be noticed that the crank-shaft is bent. This bend commences about 8 inches from the crank web. The other part of the crank-shaft is shown in front of the cylinders, with the pieces of the cylinder that were pulled out with the cover. The two bearing caps and governor balls are also shown. The mark on the end of the high-pressure cylinder is due to a scratch on the photograph negative. Fig. 2 shows the cylinders shortly after the accident. The white is the lagging.

An Easily Remembered Method of Converting Thermometer Scales

By David J. Clark

The Fahrenheit thermometer is generally used in English speaking countries, and the Centigrade in countries that use the metric system. In most scientific treatises in English, however, Centigrade temperatures are used, often without their Fahrenheit equivalents, thereby necessitating a conversion of the Centigrade to the Fahrenheit scales in order to make the readings intelligible to the average reader.

The formulas most used in effecting interconversions of these two scales are given below:

$$Temp.\ Fahr = (9/5 \times Temp.\ Cent.^\circ) + 32\ degrees;$$

$$Temp.\ Cent. = 5/9\ (Temp.\ Fahr.^\circ - 32\ degrees).$$

These formulas are strangely elusive and difficult to remember, not so much because of the dividing by 5 and the multiplying by 9, or *vice versa*, as of the difficulty in remembering on the spur of the moment, whether we first add 32 and then take 9/5 of the sum, or first take 9/5 and subsequently add the 32; or whether we subtract 32 and then take 5/9, or take 5/9 and then subtract 32. The following rule entirely obviates this difficulty:

To convert Fahrenheit temperatures to Centigrade temperatures, add 40 to the Fahrenheit reading, take 9/5 of the sum, then subtract 40.

To convert Centigrade temperatures to Fahrenheit temperatures, add 40 to the Centigrade reading, take 5/9 of the sum, then subtract 40; or by formula:

$$Cent.^\circ = 5/9\ (Fahr.^\circ + 40) - 40.$$

$$Fahr.^\circ = 9/5\ (Cent.^\circ + 40) - 40.$$

This method is simple and easily remembered, for in each case the process is exactly the same excepting the fractions 5/9 and 9/5. However, since the Fahrenheit scale has 180 divisions between the boiling and the freezing points, while the Centigrade scale has but 100 divisions between these points, no difficulty should be experienced in remembering that the larger fraction (9/5) should be used in changing Centigrade readings to Fahrenheit, and the smaller fraction (5/9) in converting the Fahrenheit scale to Centigrade.

Tornado Wrecked the Engine Room

By W. H. Meyers

The accompanying view shows what was left of the engine room of the Lisbon (Iowa) light and water plant after a tornado got through with it on Sunday, June 7, last. The engine was not damaged, but the switchboard was thrown over the

WRECK OF LISBON ENGINE ROOM

dynamo and broken to pieces, every instrument on it being damaged.

Part of the brick wall fell on the dynamo pulley and broke it; also, the lugs that support the bearing on that end. All but 30 feet of the smokestack was blown down.

In less than one hour after the storm men were at work clearing away the rubbish. On Monday, what remained of the smokestack was raised and the pump started. A temporary shed was erected, the dynamo repaired and a switchboard built of boards, covered with asbestos. All the instruments were mounted on knobs and the lights were on again after being out four nights.

A small leak in a boiler can be located by a white, wedge-shaped mark on rivets or plate. In calking, mark all the leaks first, as the hammer blows are liable to obliterate the faint marks made by the leak. Follow the seams along, keeping your eyes open for the little red or white spots which show the leaks.

POWER AND THE ENGINEER

DEVOTED TO THE GENERATION AND TRANSMISSION OF POWER

Issued Weekly by the

Hill Publishing Company

JOHN A. HILL, Pres. and Treas. ROBERT MCKEAN, Sec'y.

505 Pearl Street, New York.
6 Bouverie Street, London, E. C.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1907 *we printed and circulated* 291,500 *copies of* POWER.

Our circulation for June, 1908, *was (weekly and monthly)* 195,000.

July 7..... 36,000

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

Contents

PAGE

Setting the Valves of the Wright Steam Engine 1
Catechism of Electricity 6
A Puzzling Case of Back-firing 7
Proper Thickness of a Valve Deck in a Pump. 8
Location of Strainers 9
Design of Corliss Engine Crossheads 10
Effect of Mixture Strength and Scavenging Upon the Thermal Efficiency of Gas Engines 12
A Contractor's Boiler 12
Effects of Superheating Moist Steam 13
Lining-up a Horizontal Engine 17
An Engine in India 18
Practical Letters from Practical Men:
Mr. Johnson's Turbine Article Criticized ....Knocks in Steam Engines....Burning Sawdust....Making a Reducing Valve....Sulphuric Acid Test for Coal ....Gelatinated Oil....To Ascertain Mean Effective Pressure in Cylinders.... A Problem in Motor Connection....Poor Draft....A Home-made Ejector.... Direct Current Machines Using Carbon Brushes....A Gage Glass Packing.... Useful Formulas for Use in Designing.... Setting an Engine on Dead Center.... Draining of Steam and Water Pipes.... Fahrenheit-Centigrade Temperature Chart....Solution of Problem in Storage Battery Connections....How Can He Heat the Room?....Wasting Natural Gas. 20–27
Calculating the Strength of Riveted Joints... 28
Accident to an Engine at Berkenhead, England 33
An Easily Remembered Method of Converting Thermometer Scales 33
Tornado Wrecked the Engine Room 33
Editorials 34–35

Reinforcing Strips on Lap Riveted Joints

In consequence of an increase in the factor of safety prescribed for boilers with lap-riveted joints by the Massachusetts Board of Boiler Rules, the practice has been resorted to of reinforcing such joints with an inside strip riveted to both sheets outside the rivets of the lap-joint. This strip must be bent over the edge of the inside sheet, and there is an animated discussion among the engineers of the Bay State as to its effect upon the efficiency of the joint.

The method of computing the efficiency of a sound joint reinforced in this way is described by S. F. Jeter on page 28. He does not consider that the bend introduces sufficient flexibility to prevent the reinforcing sheet from adding its full value to the section under stress, and considers the form of joint approximately as safe as a butt-joint of the same efficiency.

The effect which the addition of the reinforcing strip would have upon the deterioration of the joint due to the "breathing" action of the boiler and the bending of the sheets under the indirect pull is another question. Obviously, it would act in the direction of resisting this movement, and would probably delay, if it did not prevent, the formation and extension of the hidden cracks which have been the manner of failure of so many joints of this type. But if a new strapped joint is to be made, it would be butted, not lapped, and the practical application of the reinforcing strip would be mainly, if not altogether, that of prolonging the usefulness of lap-riveted boilers already in service.

Such boilers are liable to have already acquired the hidden cracks. How far will the reinforcing strips go toward preventing the extension of those cracks and in holding the boiler together if the main joint fails?

There is a demand for further experimental knowledge upon the efficiency of riveted joints. The force under which a joint will fail depends upon other things than the simple tensile strength of the sheet and the resistance of the rivets to shearing. There are the friction of the plates upon themselves under the enormous pressure necessary to a tight joint, as pointed out by Professor Johnson, and the liability of the plate to crush, as pointed out in Mr. Jeter's article.

The effects of the heavier plates and larger rivets now in use, the size of rivet heads and ends, the modern methods of preparing the sheets and of machine riveting are problematical. A thorough up-to-date investigation of the subject is called for, and as the information would be of specific use to the Government in its departments of construction, and of service to the whole people in providing greater surety in constructions which involve the public safety, it would seem to be well within the province of the Federal government to utilize the testing facilities at its command at Watertown or elsewhere in supplying this information. It may be that the data accumulated in the regular work of the testing machine might furnish the information needed if analyzed and compiled. If the Government leaves the opportunity open one of our colleges equipped with the necessary laboratory might make an investigation which would become classic.

Mixture Quality and Gas Engine Efficiency

Notwithstanding Berthelot's investigation many years ago, in which he showed that the specific heat of a gas increases considerably with increasing temperature, it is only within the last few years that gas-engine experimenters have seemed to realize that this fact accounts for a good deal of the discrepancy between the actual and the theoretical pressure rise produced by combustion. More remarkable, however, appears to be the mental attitude of one of England's best investigators as disclosed by his report of results obtained in tests made recently, an abstract of which we print on page 12 of this number. Professor Hopkinson attributes the pressure discrepancy partly to the varying specific heat, but appears to consider that this relation has just been developed, if not discovered, in the course of his tests. Perhaps he meant only to declare confirmation of the idea, which, of course, is sev-years old; in view of his high standing it is only reasonable to assume this intention.

In the light of present knowledge of gases it seems to be obvious that the discrepancy between the actual and the theoretical rise of pressure due to combustion is due to the increase of specific heat, the loss of heat units to the jacket and the time element of flame propagation. Dissociation is pretty as a theory, but is not susceptible of satisfactory proof, whereas the other three phenomena have been proven and their physical results are entirely sufficient to account for the lack of developed pressure.

With a relatively lean mixture it is obvious that less gas is taken in per suction stroke and, therefore, that the specific heat of the mixture suffers less from increase of temperature; moreover there is less temperature rise, which still further improves the specific heat condition and also reduces the loss to the jacket water. Lean mixtures, however, burn more slowly than rich ones, and this must be compensated by advancing the ignition. Bearing all these points in mind it requires no actual test in order to arrive at the conclusion that the highest efficiency should be obtained with the leanest mixture that can be reliably and fully ignited

soon enough to give a prompt rise to the nearly vertical line of the diagram without entailing objectionable back pressure by advancing the time of ignition too far. Another advantage of diluting the mixture is that the compression may be increased considerably, still farther enhancing the efficiency. The present writer has seen a number of single-acting engines, running on ordinary illuminating gas of more than six hundred British thermal units per cubic foot, with compressions ranging from one hundred to one hundred and ninety pounds per square inch, absolute; most of them had one hundred and twenty to one hundred and twenty-five pounds compression. Not one back-fired, pre-ignited or otherwise misbehaved, and the gas bills were much smaller after the compression had been raised than when it was the usual seventy-five to eighty pounds. The explanation is dilute mixture and early timing of the ignition.

How Much "Bluff" is Justified?

An engineer who had had limited experience in steam-electric plants was offered a position in a street-railway power house as chief engineer. The plant was not large and the chief requirement was to see that the men did their work and kept the engines and boilers in condition for safe and efficient operation. As a matter of fact, the duties required were much the same as those he was accustomed to. After due consideration, however, the position was refused, solely because the work was slightly different from his former work and he felt that he would not be justified in shouldering the responsibility.

Aside from the correctness of this engineer's summing up of his ability, or competency, would he have been justified in assuming charge of the plant, when his doing so might have resulted in wrecked machinery? Or, should he have taken a chance, assuming that by using every-day common sense the plant could be operated without mishap until he became better equipped to cope with the exigencies which might arise? Too much confidence in oneself may bring disaster, while not enough may result in personal failure; there have been more failures due to lack of confidence, however, than can be traced to over-confidence.

In another instance an engineer of limited experience had an opportunity to become chief engineer of an electric-light plant. He decided to accept the position, taking the stand that all of the ills to which the electric-light plant is heir probably would not appear at one time, and each could be taken care of as it came up. The engineer made good, and has since been put in charge of considerably larger and more complicated plants. Was this engineer justified in taking a position which he knew he was not thoroughly competent to fill at the outset?

Another instance is that of an ambitious engineer who wished to become a boiler inspector. He had a limited knowledge of matters pertaining to such a position. For instance, in writing to POWER, he professed ignorance as to the method employed by boiler inspectors in determining the allowable steam pressure to be carried by any particular boiler. He did not know whether it is essential to know the age of the boiler, type of stays and method of riveting the joints. He applied to POWER for help in this matter. By this time the would-be inspector will have been through an examination. Whether he passed successfully we do not know. The question is: Was this man justified in seeking the appointment? In such a position an incompetent man can bring about disaster. Permitting a boiler to carry an excessive pressure through ignorance of the method employed in determining the safe pressure spells disaster. Permitting an engineer to operate a boiler in an unsafe condition means the same thing.

How far is a man justified in going? Should he seek personal advancement at the possible cost of injury to others?

Binders for Coal Briquets*

BY JAMES E. MILLS

Definite answer to the question, "What is the best binder to use in making briquets?" depends on the locality, on the character of the coal and on the purpose for which the briquets are intended. For purposes of a brief comparison consideration is given to the binders available for a coal which is fairly easy to briquet and which cakes rather readily. A few coals will briquet with somewhat less and others require greater percentages of binder, but an endeavor has been made in the following summary to strike a reasonable average.

The experiments herein reported show that, in general, for plants situated where it can be obtained, the cheapest binder will prove to be the heavy residuum from petroleum, often known to the trade as asphalt. Four per cent. of this binder being sufficient, its cost ranges from 45 to 60 cents per ton of briquets produced. This binder is particularly available in California, Texas and adjacent territory.

Second in order of importance comes water-gas tar pitch. From 5 to 6 per cent. usually proving sufficient, the cost of this binder ranges from 50 to 60 cents per ton of briquets produced. As water-gas pitch is also derived from petroleum, it will be available more particularly in oil-producing regions.

Third in order of importance is coal-tar pitch. Being derived from coal, this binder is very widely available. From 6.5 to 8 per cent. will usually be required, and the cost ranges from 65 to 90 cents per ton of briquets produced.

Of local importance, where the price permits, are natural asphalts and tars derived from wood distillation. The price of each of these binders varies greatly with the locality, but there are doubtless places where they could compete with the binders above mentioned. Wax tailings could be used with an easily caking coal.

Pitch made from producer-gas tar is not yet on the market, but it will produce excellent briquets, with a lower percentage of binder than other coal-tar pitches. It will doubtless be available in the future.

Briquets excellent in all respects except that they are not waterproof can be made by using 1 per cent. of starch as a binder, the cost of which is 20 cents per ton of briquets produced. Extra care is necessary in drying and handling these briquets, and this adds to their cost.

The waste sulphite liquor from paper mills also produces excellent briquets except that they are not waterproof. At present it is a troublesome waste product dissolved in much water. Its utilization for this purpose will bear further investigation.

Of inorganic binders, magnesia might be utilized, as its probable cost would not exceed 22 to 30 cents per ton of briquets produced. Other inorganic binders, while available as regards price, would not make first-class briquets.

The making of briquets from lignite coal offers a peculiarly difficult problem. If the lignite cakes in the fire, asphaltic residues from petroleum or water-gas tar pitch may be used as binder, larger percentages being required than for ordinary coals. The most promising binders for lignites that do not cake are starch, sulphite liquor, and magnesia. Lignites may be made into briquets without binder if they are to be burned on grates specially constructed to overcome the tendency to fall to pieces in the fire.

Attention is called to the suggested method of deciding as to the value of coal-tar pitch for briquet purposes. The method is likewise applicable to asphalts and petroleum residues generally: (1) The pitch or tar is distilled and all oils coming off below 270 degrees Centigrade are rejected as being of no value; (2) the flowing point of the portion to be used is determined (this should generally not be less than 70 degrees Centigrade; (3) the pitch is extracted with carbon disulphide. The smaller the amount of residual carbon the more satisfactory is the pitch. The less readily the coal cakes the higher must be the flowing point of the pitch. If a pitch cracker is used, the pitch to work successfully on a hot summer's day must have a flowing point above 120 degrees Centigrade. In the winter pitch with a flowing point of 100 degrees Centigrade may be used. All softer pitches and asphalts have to be melted and mixed in liquid form with the coal.

*From investigations made at the fuel-testing plant at St. Louis, Mo. Bulletin 345, United States Geological Survey.

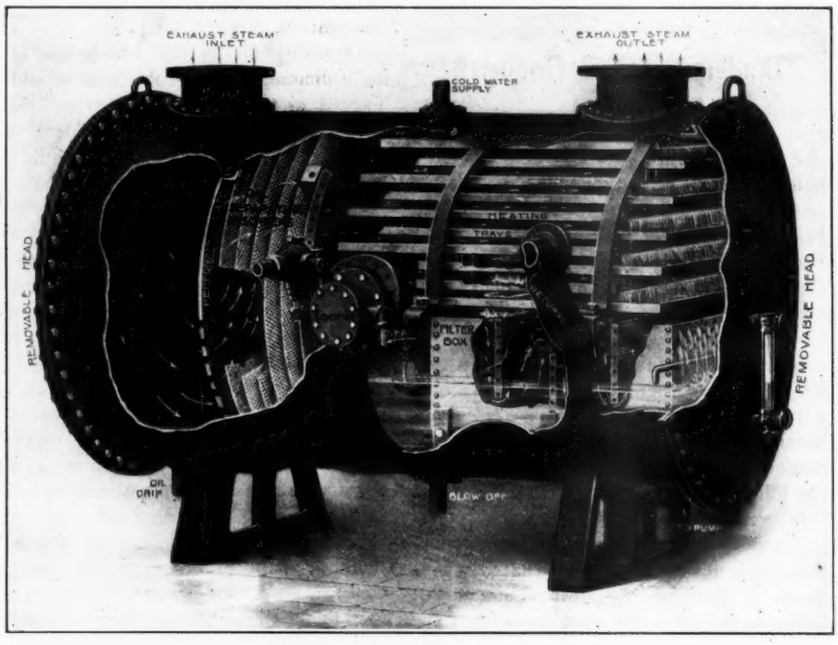
Power Plant Machinery and Appliances

Original Descriptions of Power Devices
No Manufacturers' Cuts or Write-ups Used

MUST BE NEW OR INTERESTING

Linton Combination Feed Water Heater, Purifier and Oil Extractor

A combination feed-water heater, purifier, oil separator, muffler, return tank and pump governor is being manufactured by the Linton Machine Company, 26 Cortlandt street, New York City. The apparatus is well illustrated in the half-tone view shown herewith. The exhaust inlet is placed on top at one end of the body, the steam entering a large expansion chamber, where its velocity is reduced. It then passes through a perforated plate, to break it up before reaching the oil-separating screens, after which it passes through a second perforated plate, as shown. The second plate has perforations in the upper half only, so the lower part serves as a dividing wall, or diaphragm, to prevent the liberated oil from coming in contact with the feed-water.



THE LINTON COMBINATION HEATER

The steam next passes to the tray chamber, in which are hung several layers of trays, so arranged that the feed-water entering through the cold-water supply pipe falls into the top tray and passes over the open end into the next lower tray. This flow from tray to tray is repeated until the water has traversed the entire set of heating trays, which are also intended to act as depositaries for such carbonate of lime, magnesia, etc., as the water may contain. From the lower tray the water passes to the filter-box, which is filled with coke. Entering at one end, the water is forced to percolate up and down through the entire length of the filter-box owing to the presence of baffle-plates, as shown, the water finally passing out through the perforations in the end of the box. This process is expected to remove any impurities that may have been retained in the passage over the trays. It is seen that the exhaust steam passes over and under each tray and finally escapes through the exhaust-steam outlet.

The returns enter through a pipe at the side of the tray chamber, passing over the lower trays only, where they regain the few degrees of heat lost, and then pass through the coke filter before mingling with the hot water in the tank. The hight of the water in the tank is regulated by a governor controlled by a float attached to a balance valve and designed either to regulate the steam for the boiler feed-pump, or the cold-water supply to the heater.

As both heads are removable without interfering with pipe connections, there is nothing to prevent frequent changing of the trays, if necessary, and removing the filter-box, which is placed on rollers, for removing the coke and replacing it with clean filtering material. It also affords easy inspection of the entire filter. The apparatus is made in both horizontal and vertical styles and can be used merely as a muffler and oil separator in connection with a closed heater.

"Riggin" Angle Blow-off Valve

This valve is a combined port and seat valve with an unobstructed discharge. The

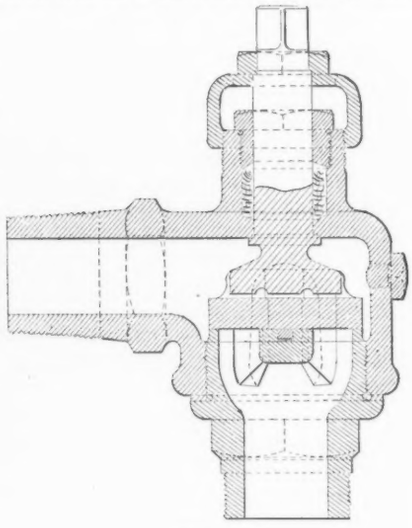


FIG. 1

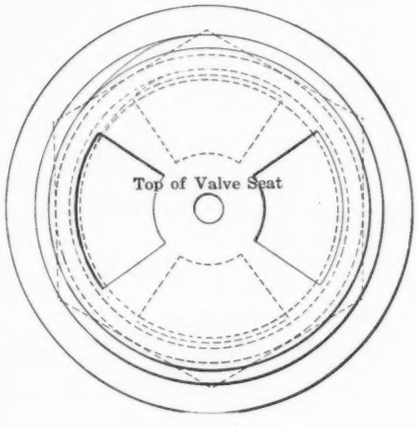
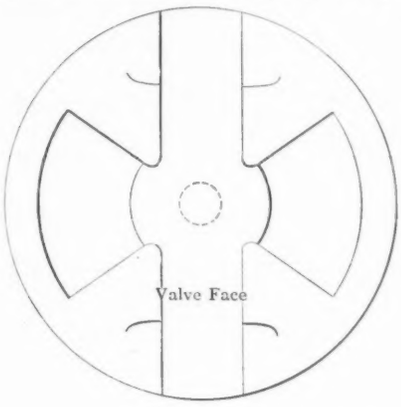


FIG. 2

disk rotates on the seat of the valve, the lock-nut on the stuffing-box locking it on the seat. This lock-nut, when screwed up, also holds the stem of the valve to the ground joint, permitting the valve to be

packed under pressure; the pressure also holding the disk down on the seat and automatically closing the valve. The valve is shown in the sectional view, Fig. 1, Figs.



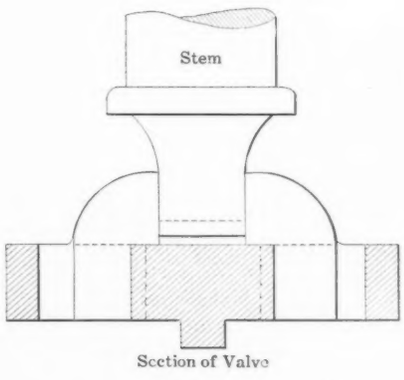


FIG. 3

2 and 3 showing the construction of the valve seat and valve.

The only parts subject to deterioration are the seat and disk, which are easily repaired or renewed without removing the body of the valve from the pipe. This is accomplished by disconnecting the seat from the body, when the disk can be taken out and re-seated, or duplicate parts put in.

This valve is manufactured by the Monarch Machine Works, 714 Green avenue, Altoona, Penn.

A Pneumatic Engine Stop and Protection System

A system designed to prevent damage to an engine, due either to excessive speed, hot bearings or water in the cylinder, is illustrated and described herewith. Fig. 1 shows the method of applying the device to various parts of the engine, *A* representing an automatic valve in the steam pipe, above the throttle valve, *B* an auxiliary valve, *C* a diaphragm, *D* a speed-limit trip valve and *E* a speed-limit governor. On the main pillow-block is the hot-bearing attachment *F*, while at *G* and *H* are located the cylinder-release valves. A compressed-air or feed-water pressure tank is located below the floor line of the engine room, as shown. The pipes *J* and *K* are the exhaust and distribution, respectively, passing to the factory.

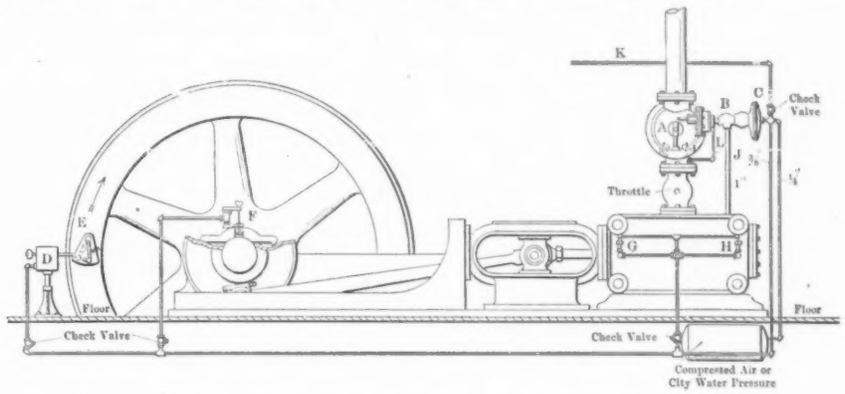


FIG. 1. ENGINE EQUIPPED WITH ENGINE STOP AND PROTECTION SYSTEM

The main valve, shown in detail in Fig. 2, contains a semi-rotary ported valve *A*, having a full pipe opening in a very small movement and fitted loosely to the stem

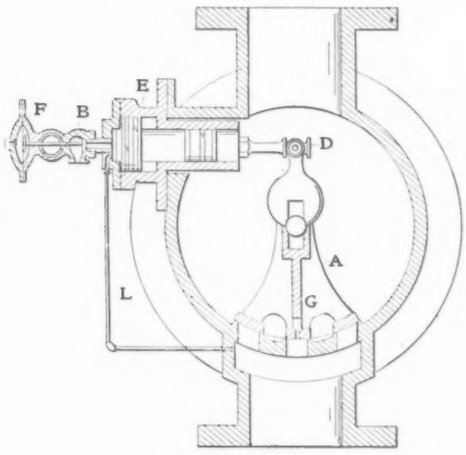


FIG. 2

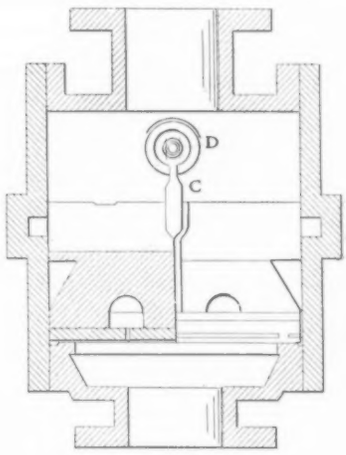


FIG. 3

B which is cast on a rocker-arm *C*, Fig. 3, and actuated through the medium of the stud *D* by the differential piston *E*, which is operated by the diaphragm *F*.

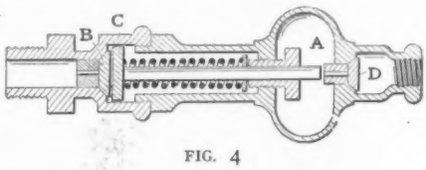


FIG. 4

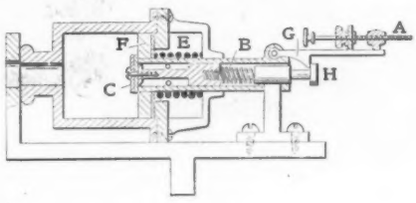


FIG. 5

When the pressure is exhausted from the diaphragm, the auxiliary valve *B* will be unseated, allowing the pressure to be exhausted from the large end of the differential piston *E*; the pressure on the small end will then throw the valve into a closed position, as shown in Fig. 2. This brings the small equalizing port *G* over the central port in the valve and allows a small quantity of steam to blow through as soon as the throttle valve is closed. This creates a pressure which passes through the small pipe *L*, equalizes the pressure on the differential piston and automatically shifts it to an open position. The diaphragm *F* may be operated manually by a valve placed at any distance from the engine.

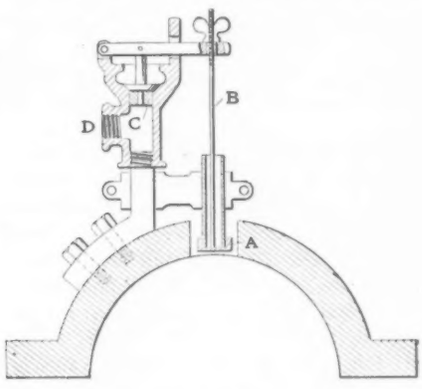


FIG. 6

The details of the cylinder-release valve are shown sectionally in Fig. 4. The shank

is inserted in the indicator pipe holes of the engine, the upper end being piped to the diaphragm, as shown in Fig. 1. The nut *A* is screwed down to bring sufficient tension on the spring to keep the valve *B* seated under normal conditions. Should a pressure occur in the cylinder due to water, or from any other cause, the valve *B* would raise the piston *C*, which in turn would raise the valve *B* and exhaust the pressure from the diaphragm *C*, Fig. 1. thus causing the main valve to close and stop the engine.

The speed-limit valve is shown in detail in Fig. 5. The position of the valve, as shown, is closed and ready for action. The valve is piped to the diaphragm (see Fig. 1) and if the rod *A* should lift, the spring *B* would unseat the valve *C*, which would exhaust the pressure from the diaphragm and cause the main valve to shift to a closed position. After the pressure has decreased, the spring *E* causes the piston *F* to follow the valve *C* and re-seat on it, and as the pressure is re-established in the system, it counteracts the resistance of the springs *E* and *B*. Owing to the large area of the piston *F*, the latch *D* will engage in the head *H* and the valve will automatically re-seat itself.

The hot-bearing attachment, shown in detail in Fig. 6, operates as follows: If the shaft should become hot, it will communicate heat to the cap *A*, to which is soldered the rod *B*. As the solder melts at a much lower temperature than babbitt, this connection is melted and the pressure will unseat the valve *C*, which is connected to the diaphragm (Fig. 1) by means of a pipe connection from *D*. This exhausts the pressure from the diaphragm, which will cause the main valve to close and shut the engine down.

This system is the invention of R. H. R. Rockwell, Mt. Vernon, Ill.

Angell Steam Trap

The Angell steam trap, manufactured by the Angell Manufacturing Company, Rochelle Park, N. J., is shown herewith. The trap is simple in construction. By introducing a long-shank valve-stem the weight lever acts with the float lever in lifting the valve. As soon as the valve starts to open the weight lever acts independently by lifting it full open. While the trap is discharging the weight resists any tendency of the valve to close, thus preventing the shock of full steam-hammer on the valve seat. As the float operates up and down, the valve, which is free to turn, is revolved. The outlet, being very low, is water-sealed, and the valve is protected by a screen against all sediment. There is but one valve.

The pressure on the valve when closed is greater than the resistance of the weight lever opposing it, and the incoming water, raising the float lever, throws the weight lever on its upward movement, opening the valve, and closing it on its return movement. The water discharges between the valve and seat and does not pass out along the body of the valve and casing; therefore, the outlet is of the same area as the valve. The trap acts intermittently only at high pressure; when the pressure on the area of the outlet becomes equal to the resistance of the weight lever, the intermittent action ceases, which occurs at a pressure of 40 pounds. The low-pressure traps are of the continuous-flow type.

Steam Turbine Improvement

Brown, Boveri & Company have recently patented the improvement in steam turbines shown diagrammatically in the accompanying illustrations, which are taken from *The Mechanical Engineer*. The improvement consists in so proportioning the rotating parts that they are, toward the inlet end, thicker than is necessary merely for purposes of strength in order to provide an additional mass of metal in the rotating parts so that they shall take as long, or longer, to heat up than the opposing stationary parts.

Fig. 1 is a partial section through the turbine drum and casing showing the casing *A* arranged with steps or stages of gradually diminishing thickness of metal. The turbine drum, however, is made of substantially equal thickness throughout the whole of its length.

In Fig. 2 the thickness of the drum is decreased from the inlet to the outlet. Thus at the point *F*, where the pressure and temperature of the steam have decreased sufficiently to cause an appreciable difference in expansion of the metal, there is arranged a step from the thicker to the thinner metal. This thickness of metal is retained up to the point *G* where another step is formed.

In Fig. 3, instead of arranging the drum in steps as shown in Fig. 2, the turbine

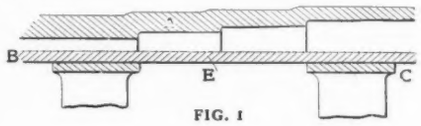


FIG. 1

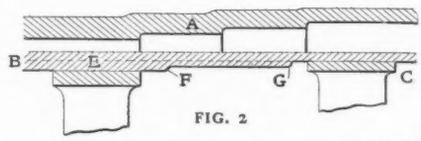


FIG. 2

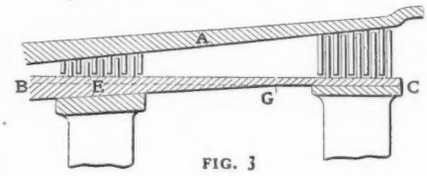
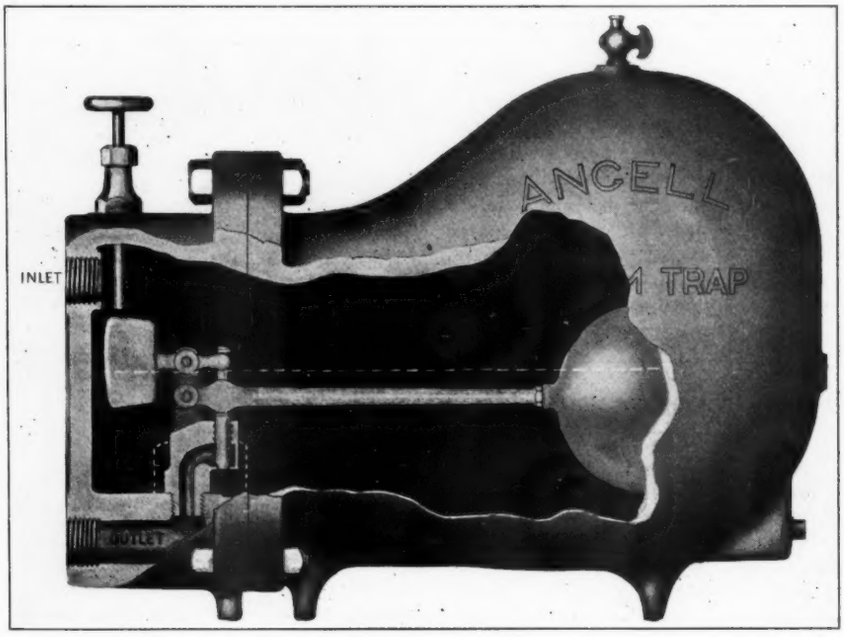


FIG. 3

casing *A* is formed with a taper, and the drum *E* is also formed with a corresponding taper which continues to the point *G*.

In Figs. 2 and 3 the line *B C* indicates the original thickness of the turbine wheel, that is, the thickness similar to that shown in Fig. 1, this thickness being, of course, arrived at by calculation. By adding the metal shown in Figs. 2 and 3 the expansion of the parts at the inlet end is delayed because of the greater amount of metal which requires to be heated, and the time taken to heat the drum is equalized to that required to heat the casing.

It will also be seen from Figs. 2 and 3 that the arms of the turbine wheel are made of larger dimensions at the inlet than at the outlet end.



ANGELL STEAM TRAP

Inquiries

Questions are not answered unless they are of general interest and are accompanied by the name and address of the inquirer.

Pressure on Crank Pin

If the cylinder of an engine is 50 inches in diameter, with 110 pounds pressure and 45 pounds receiver pressure what will the stress be on the pin? If the pin is of 12 inches diameter and 14 inches long, what will the load be on the projection?

J. B.

A 50-inch piston has 1963.5 square inches of area. The maximum unbalanced pressure will be 110 — 45 = 65 pounds per square inch, and the pressure upon the whole area: 1963.5 × 65 = 127,627.5 pounds.

The projected area of the pin is 12 × 14 = 168 square inches, and the pressure per square inch of projected area: 127,627.5 ÷ 168 = 759 pounds.

Effect of Depth upon Flow in Artesian Wells

I heard an engineer say that an artesian well 500 feet deep will furnish 67½ gallons per minute at the bottom and will rise within 19 feet of the top, or 481 feet, and will only furnish or supply 37 gallons 19 feet from the top. Is there a rule? Will a well of that kind furnish more or less near the sea level or in a mountainous region?

L. J. S.

If any way can be devised by which the water can be taken out of the top of the well as fast as it flows in at the bottom, a well will supply all the water that flows to the bottom regardless of the depth or hight above sea level.

Atmospheric Pressure

When the barometer stands at 30 inches, the pressure of the atmosphere is 14.7 pounds per square inch. What is the atmospheric pressure per square inch when the barometer stands at 29.5 inches?

W. E.

As the mercury column of the barometer depends upon the pressure of the atmospheric pressure per square inch proportional to the pressure. Thus

30 : 14.7 : : 29.5 : 14.47.

Other pressures may be determined in the same way. Suppose the barometer reading to be 28.25, then

30 : 14.7 : : 28.25 : 13.86.

Operating a Water Wheel and Engine Together

The mill requires, approximately, 150 horse-power to run when the machinery is loaded to full capacity. For eight months during the year a water-wheel is used for power. For four months, only 60 horse-power can be got from the wheel. The flow of water to the wheel is steady. The company wishes to install (as auxiliary power) a 125-horse-power engine, both "hooked" to the same end of the line shaft. How may the two powers, working together, be arranged so as to get as much as possible out of the wheel? Can the engine be run without a governor? Can one governor be arranged to regulate both?

O. J. O.

Water is cheaper than steam, and the object is to use all the water you can, and as little steam as possible. To do this, set the governor on the water-wheel so it will be wide open when the wheel is running at the desired speed, but will close before the speed gets dangerously high, so that the wheel will not run away with the shaft when the load is light. Then set your engine governor so as to keep the engine at the desired speed. Arranged in this way, the wheel will take all of the load that it can carry, and the engine will do the rest.

Should Engine Shaft and Cylinder be in Same Plane?

In setting up an old engine a short time ago, I found the crank-shaft one-half inch higher than the center of the cylinder. Everybody I have talked to says it does not make any material difference. Does it? It is a slide-valve engine, used for running a dynamo, and is run at 200 revolutions per minute.

F. N. P.

There is no particular reason why the center of the engine shaft should lie in the same plane with that of the cylinder. The effect of this offset is to give a turning effect on the crank through more than one-half of the crank-pin circle during one stroke and less than one-half during the other stroke; but ordinarily the difference is so slight as to be negligible. Some types of single-acting vertical engine are designed with a considerable offset with the end in view to avoid a dead center in a two-cylinder engine with cranks set 180 degrees apart.

Packing for Brine Pumps

What is the best kind of packing to use in a brine pump? I am operating a private refrigerating plant, and in order to "drive" the brine through the boxes and showcases to be cooled I have to "choke" my delivery to the main tank or reservoir from which the brine is pumped. This, of course, makes my pump work under a varying pressure of between 40 and 80 pounds per square inch. I have great trouble in keeping brine in the tank, owing to leakage in the pump. It is a power pump driven by a gas engine. The rod is an inch or an inch and a quarter in diameter. I have tried several different kinds of packing, but in a very short time (a week or two) they seem to crystallize, and no amount of tightening will stop the leak. The rod is in first-class condition and free of scores.

T. G.

We are inclined to think that there must be some cause other than the pressure you mention for the trouble you are encountering with your packing a pump against a pressure of 80 pounds, with any of the first-class packings recommended by the manufacturers represented in the advertising columns of POWER AND THE ENGINEER. If, as you say, the rod is in first-class condition we would suggest that you make sure that the pump is in line. This you can readily do roughly without taking off the cylinder-heads, by simply shutting off the suction and discharge of the pump, draining the cylinder, removing the packing and calipering between the rod and the sides of the stuffing-box at different positions of the stroke. If you will send a sketch of the pump, connection tank and coils showing the maximum head pumped against so that we can get an idea of the cause of your having to throttle the discharge in order to drive the brine through the boxes and showcases to be cooled, we will be pleased to see if we cannot figure out another means of overcoming the difficulty.

Hydroelectric Power in Japan

A 60,000-volt transmission line has been placed in service to bring energy from a hydroelectric station on the Ugigawa river to Tokyo, Japan, 25 miles. The station contains six 3000-kilowatt generators furnishing 50-cycle, 6500-volt current. This is stepped up by water-cooled transformers to 60,000 volts, at which potential it is transmitted to a sub-station just outside the city. Here there are water-cooled transformers which reduce the line potential to 11,000 volts, at which it is transmitted underground through lead-armored cables to eleven distributing stations in various parts of the city. In each of these smaller stations there are oil-cooled transformers reducing the voltage to 2000 volts.

Dartmouth College conferred on C. J. H. Woodbury, at its commencement, June 24, the degree of Doctor of Science, this being the second time that he has received this degree, the first being from Union College, New York, in 1906.

The Holland-American Line entertained a number of guests at dinner on board of its new twin-screw steamship "Rotterdam," at the company's pier at Hoboken, N. J., Wednesday evening, June 24.

If the gasket will not "stay put" under a valve bonnet, make sure that the machine bolts are not wasting their energy in compressing dirt in the bottom of the threaded holes.

The Engineers' Club of Philadelphia has removed from 1122 Girard street, that city, to 1317 Spruce street.

Personal

James J. Markham has been elected a delegate to represent Lowell Association No. 17, N. A. S. E., at the national convention to be held at Denver, Colo., in September.

Stephen G. Hobart has been appointed a member of the advisory board of consulting engineers of the Chicago smoke-abatement commission and the city department of smoke inspection. Mr. Herbert is a Chicago consulting engineer. He was graduated at Cornell University in 1896, and has since had charge of engineering work in different States, among them being those of Swift & Co., of Chicago, the Solvay Process Company, of Syracuse and Detroit, and the Eastman Kodak Company, of Rochester. This appointment fills the vacancy due to the recent resignation of A. Bement.

Business Items

The York Manufacturing Company, York, Penn., manufacturer of ice-making and refrigerating machinery, received 24 orders recently, aggregating 861 tons of refrigeration.

The Kennedy Valve Manufacturing Company, Elmira, N. Y., has gotten out a neat advertising design in the shape of a gold-mounted leather watch fob, and will send one to each purchaser of valves, upon request.

The Filer and Stowell Company, of Milwaukee, Wis., builder of heavy-duty Corliss engines, is again represented in Chicago and vicinity by Frank Engelhardt, with an office at 735 Marquette building. Mr. Engelhardt, with the exception of a short period, has been handling the Filer and Stowell engines for about ten years.

Wm. B. Scaife & Sons Company, of Pittsburg, Penn., has moved its New York office to the Havemeyer building, 26 Courtlandt street. H. F. Reynolds is in charge and will give attention to the line of structural steel work, steel tanks and barrels, water filters and water softening apparatus handled by this company.

The Murray Iron Works Company, Burlington, Iowa, does not seem to have been affected by any "hard times" talk; it has sent us a list of 36 orders for Murray Corliss engines, aggregating 8215 horse-power, received since the first of January; also 61 orders for Murray tubular boilers, aggregating 7140 horse-power, and 10 Murray water-tube boilers, aggregating 3075 horse-power.

The increasing demand for Bird-Archer boiler compounds has necessitated the appointing, by the Bird-Archer Company, of representatives as follows: Chicago, Golden Rule Oil Co., 171 Washington street; Baltimore, Maryland Railway and Electric Supply Company, 604 Continental building. The Philadelphia office of the Bird-Archer Company has been moved from 56 North Delaware avenue to 119 South Fourth street.

Adam Cook's Sons, 313 West street, New York, makers of Albany grease, recently received a letter from H. N. Saxton, Jr., president of the Knoxville Saw Mill Company, Limited, Knoxville, Tenn., which tells of an interesting experience with Albany grease. We quote: "Friends of ours some time ago had trouble with the bearings on the bottom shaft of a band resaw. They said they had tried everything that had been suggested, but still the bearing continued to heat. An expert was called in and said the shaft must have sprung. They took out their shaft and had it trued up, but the bearing still got hot until they asked our advice and we recommended Albany grease which they tried and have had no further trouble. We had the same experience some time ago with the bearings on our band mill on account of the strain. The box kept burning out and we decided to try Albany grease on this bearing and have had no further trouble."

The Sirocco Engineering Company, of New York, has been advised by the foreign attorneys for S. C. Davidson, of Belfast, Ireland, the original inventor and manufacturer of "Sirocco" fans, that a decision has been rendered in the suit brought by Mr. Davidson against the Siemens Schuckert Werke for infringement of his German patent for "Sirocco" centrifugal fans and blowers. This patent includes an unobstructed intake chamber within the drum-like series of shallow blades, and the defendants undertook to evade this feature by extending six of the blades inwardly, arguing that they thus subdivided the intake chamber so that it was no longer an "unobstructed" chamber. The court decides that this variation does not save the defendant's fan from infringement, and the judgment of the court restrains the defendant from selling similar fans, and imposes upon them the costs of the suit. Following this decision a German company, the Sirocco Gesellschaft, has been formed for the manufacture of "Sirocco" fans, which are to be constructed at the works of the Algemeine Electricitat Gesellschaft.

Help Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Thoroughly competent packing salesmen. Box 81, POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn St., Chicago.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

WANTED—Salesman on commission for high grade power specialties. Address, stating experience, Chas. T. Luce Co., 160 Congress St., Boston, Mass.

WANTED—Competent salesmen to handle metallic packing on commission in exclusive territory. Address, giving experience and references, Huhn, 1876 Broadway, N. Y.

Situations Wanted

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

SITUATION wanted with engineering concern or in charge of plant by man experienced in sales, design, erection and operation. Power plants and power transmission, reciprocating and turbine. References. Box 3, POWER.

POSITION WANTED as chief engineer; experienced with all kinds of engines, steam turbines, a.c. and d.c. generators, motors and switchboards, boilers and pumps; I can get results and furnish the references; have been seventeen years in the mechanical and engineering business. Box 9, POWER.

WANTED—Position as chief engineer in small plant or assistant in large plant, electric preferred, by single man, 32 years of age, having twelve years' experience with high and low speed engines, a.c. and d.c. generators and motors. Can come at once. Best of references. Box 10, POWER.

Miscellaneous

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ALL PRACTICAL ENGINEERS should apply to Wm. O. Webber, Consulting Engineer, 432 Exchange Bldg., Boston, for information concerning tables on all engineering subjects.

A PRACTICAL ENGINEER wishes to instruct engineers in the use of the slide rule by correspondence. Write for particulars. Address Geo. W. Richardson, 2181 W. 24th Place, Chicago, Ill.

IF YOU DESIRE to learn the latest improvement in steam boilers, correspond with the Detroit Water Tube Boiler Co., Detroit.

ENGINES AND BOILERS, ½ to 2 h.p. engine castings in sets. Models and general machine work. Sipp Electric and Machine Co., Paterson, N. J. Catalog 4c.

PATENTS—H. W. T. Jenner, patent attorney and mechanical expert, 608 F St., Washington, D. C. I make free examination and report if patent can be had, and exact cost.

ENGINEERS AND FIREMEN—Send 10 cents in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2703 Cass Avenue, St. Louis, Mo.

PATENTS secured promptly in the United States and foreign countries. Pamphlet of instructions sent free upon request. C. L. Parker, Ex-Examiner U. S. Patent Office, 4 Dietz Bldg., Washington, D. C.

ENGINEERS, firemen, electricians, machinists, etc. New 25-page pamphlet containing questions asked by the examining boards sent free upon request. Geo. A. Zeller Book Co., 4468 W. Belle Place, St. Louis, Mo. Established 1870.

WANTED—Bids for mechanical plant. The board of control of the territory of Arizona will receive up to noon of the 30th day of July, 1908, sealed proposals for a mechanical plant for the territorial prison at Florence, Pinal county, Arizona. For information apply to Thornton Fitzhugh, architect, Phoenix, Arizona. The right to reject any and all bids is reserved by the board. By order of the Board of Control, James J. Riggs, Secretary.

For Sale

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—12x7x10", 54 revolutions, Worthington pump for 150 pounds water pressure. Straight Line Engine Co., Syracuse, N. Y.

150 HORSE-POWER tandem compound Corliss engine, in good order; 16-ft. wheel; 24 in. face. F. W. Iredell, 11 Broadway, New York.

FOR SALE—Buckeye engine, 150 to 175 h.p., good as new, great bargain for cash. Can be seen in operation. Address No. 1001 Arcade Bldg., Philadelphia, Pa.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

FOR SALE—The patent rights of one of the best steam traps and oil fifiters manufactured. A bargain if sold quickly. Parties reason for selling being the desire to retire from business. Box 85, POWER.

FOR SALE—Territory rights to manufacture a metallic packing with an established reputation. Highly recommended by all users. Equipment costs very little. Excellent opportunity for hustlers in all manufacturing districts. Very favorable terms. Also own foreign patents. Box 7, POWER.

Alphabetical Index to Advertisers

	PAGE
Ajax Iron Works	150
Alberger Company, A. H	150
Alberger Condenser Co	146
Allan & Son, A	154
American & British Mfg. Co	159
American Boiler Economy Co	149
American Diesel Engine Co	153
American District Steam Co	140
American Engine Co	155
American Goetze Gasket & Packing Co	110
American Huhn Metallic Packing Co	111
American Injector Co	130
American Mfg. Co	87
American Pulley Co	118
American Spiral Pipe Works	124
American Steam Gauge & Valve Mfg. Co	89
American Steam Packing Co	111
Anderson Co., V. D	99
Ashton Valve Co	124
Austin Separator Co	100

You Can Coin Silence

When it results from New Process Raw Hide Pinions which protect the entire equipment from wear, save power and permit higher operating speed. Catalog?

New Process Raw Hide Company,
Syracuse, New York.

WHAT! NO INDICATOR?

Don't you know that I can give you a fine up-to-date outfit, new, from $25.00 up, and that I will let you pay a part of it acting as my agent in your spare time?

I will give you a thorough course of indicator instruction with a fine indicator to practice with for $5.00 per mo. Catalog?

Extra ¼ in. Area Cyl. for Ammonia, Gas Engine and high pressure work.

A. C. LIPPINCOTT, Newark, N. J.

THE BRISTOL COMPANY

Manufacturers of

BRISTOL'S RECORDERS

For Pressure, Temperature and Electricity, also

Wm. H. Bristol

ELECTRIC PYROMETERS AND FRICTIONLESS RECORDERS

The Bristol Company,
Waterbury, Conn.

New York Chicago

Optimism and Stephenson Bar Belt Dressing

Make "the wheels go 'round"

Best for the money and best for *you*.

We have a FREE Sample for you to prove it.

This is the day to write us for it.

RED LABEL FOR LEATHER BELTS.
GREEN LABEL FOR CANVAS OR RUBBER BELTS.

Of Dealers everywhere or

Stephenson Mfg. Co., Albany, N. Y.

Agents for England, J. B. Stone & Co., Finsbury Pavement, London

HARBISON-WALKER REFRACTORIES CO.

PITTSBURGH, PA.

Makers
Highest Grade Refractories

Importers
Chrome Ore

Sole Agents
Carl Spaeter Magnesite

Fire Clay, Silica, Magnesia, Chrome **BRICK**

Bricks and Shapes for Setting all makes of Boilers and Stokers,

Hundreds of Installations

Longest Service

Greatest Economy

7,500 Regular Customers

Write for Booklet P

1,200,000 Daily Capacity

TURN

a key when you wish to adjust the Mason Reducing valve to any desired pressure.

LOOK

how simple it is to regulate the air, water or steam supply. Write for a Catalog.

The Mason Regulator Co., Boston, Mass.

FLINN DIFFERENTIAL STEAM TRAPS

Save their Cost by Increasing Engine Efficiency.

THE EDWARD P. ALLIS COMPANY, Milwaukee, Wis.
[AFTER SELLING OVER 500 FLINN TRAPS.]

Replying to yours of the 17th inst., we would say that we have used the FLINN DIFFERENTIAL STEAM TRAP for a number of years, practically since its first introduction, and have found it the most general satisfactory trap we have ever used.

Yours, truly,
[Signed] THE EDWARD P. ALLIS COMPANY,
By Irving H. Reynolds.

DESCRIPTIVE CIRCULAR ON REQUEST.

RICHARD J. FLINN, West Roxbury Station, Boston, Mass.

FOR SALE BY ALL SUPPLY HOUSES

50 CTS. PER STICK, $5.00 PER DOZEN

It is the only article that will prevent sparking. Will keep the Commutator in good condition and prevent cutting. Absolutely will not gum the brushes.

It will put that high gloss on the Commutator you have so long sought.

K. McLennan & Co., Sole Manufacturers
411-130 Dearborn St., Chicago, Ill.

	PAGE
Babcock & Wilcox Co	148
Ball-Cooley Engineering Co	150
Ball Engine Co	159
Ball & Wood Co	125
Baragwanath & Son, Wm	143
Bard Union Co	129
Barnes Co., W. F. & John	144
Bass Fdry. & Machine Co	154
Beggs & Co., James	99
Berry Engineering Co	150
Best Mfg. Co	125
Bigelow Co	148
Bignall & Keeler Mfg. Co	127
Binghamton Boiler Compound Co	133
Bird-Archer Co	133
Blake Pump & Condenser Co	144
Bowers Rubber Works	110
Brandt, Randolph	110
Bridgeport Metallic Packing Co	110
Bristol Co	83
Brown Engine Co., C.H	154
Bruce-Meriam-Abbott Co	152
Buckeye Boiler Skimmer Co	133
Buckeye Engine Co	157
Buffalo Forge Co	103
Bulkley, Henry W	146
Burt Mfg. Co	10
Carey Co., Philip	132
Central Station Steam Co	142
Chaplin-Fulton Mfg. Co	149
Chapman Ball Bearing Co	119
Chapman Valve Mfg. Co	125
Chuse Engine & Mfg. Co	154
Clark Bros. Co	157
Cleveland Flue Cleaner Mfg. Co	134
Climax Smoke Preventer Co	139
Cling-Surface Co	119
Cook's Sons, Adam	111
Cooper Co., C. & G	156
Crane Co	123
Crosby Steam Gage & Valve Co	128
Cruise & Co	150
Curtis & Curtis Co	127
Dart Mfg. Co., E. M	127
Davis Co., John	123
Davis Regulator Co., G. M	120
Dean Bros. Steam Pump Wks	145
Dearborn Drug & Chemical Works	5
De Laval Steam Turbine Co	161
De La Vergne Machine Co	153
Deming Co., The	146
Desmond-Stephan Mfg. Co	130
d'Este Co., Julian	102
Detroit Leather Specialty Co	110
Detroit Lubricator Co	113
Detroit Stoker & Fdry .Co	139
Direct Separator Co	99
Dixon Crucible Co., Joseph	114
Dodge Mfg. Co	114
Du Bois Iron Wks	151
Dunham Co., C. A	98
Eastwood Wire Mfg. Co	124
Erie Mfg. & Supply Co	143
Eureka Packing Co	107
Fidelity & Casualty Co	112
Fishkill Landing Mach. Co	158
Fitchburg Steam Engine Co	158
Flinn, Richard J	83
Flower Steam Specialty Co., Walter L	113
Foos Gas Engine Co	150
Franklin Boiler Works Co	147
Fulton Iron Works	156
Gandy Belting Co	118
Gardner Governor & Separator Co	146
Garlock Packing Co	1
General Electric Co	160
Golden-Anderson Valve Specialty Co	124
Goulds Mfg. Co	145
Green Engineering Co	140
Green Fuel Economizer Co	141
Greene, Tweed & Co	109 and 114
Griffith & Wedge Co	154
Griscom-Spencer Co	142
Hammel Oil Burner Co	140
Harbison-Walker Refractories Co	83
Harris Oil Co., A. W	112
Harris Steam Engine Co., Wm. A	155
Harrisburg Fdry. & Machine Works	157
Harrison Safety Boiler Wks	95
Hawkeye Compound Co	134
Heine Safety Boiler Co	149
Hercules Float Works	129
Hershey Mach. & Fdry. Co	99
Hewes & Phillips Iron Wks	145
Hill Publishing Co	96 and 116
Hoffman, Geo. W	133
Home Rubber Co	105
Homestead Valve Mfg. Co	124
Hoppes Mfg. Co	140
Houchin-Aiken Co	96
Hussey, McCann & Co	99
Huxley Valve Co	124
Huyette Co., Paul B	128
Ide & Sons, A. L	154
International Correspondence Schools	116
Jefferson Union Co	129
Jeffrey Mfg. Co	103
Jerguson Mfg. Co	128
Johnson Co., Henry	111
Keasbey, Robt. A	111
Keeler Co., E	147
Kellogg & Co., E. H	112
Kelly Fdry. & Machine Co	138
Kennedy Valve Mfg. Co	124
Kerr Turbine Co	161
Kewanee Boiler Co	147
Keyes & Son, F. E	144
Keystone Lubricating Co	3 and 163
Kunkle & Co., E. B	124
Lagonda Mfg. Co	134
Laminated Belting Co	115
Lammert & Mann	124
Leavitt Machine Co	126
Liberty Mfg. Co	9
Ludlow, M. B	96
Lippincott S. S. & S. Co	83
Loew Mfg. Co	127
Lord Co., Geo. W	93
Ludlow Valve Mfg. Co	123
Lunkenheimer Co	8
McClave-Brooks Co	7
McCrea & Co., James	129
McIntosh, Seymour & Co	158
McLennan & Co., K	83
McLeod & Henry Co	139
Manzel Bros. Co	112
Marion Incline Filter and Heater Co	142
Martin Grate Co	136
Mason Regulator Co	83
Mathews, Hugh	153
Mayville Specialty Mfg. Co	139
Mechanical Rubber Co	109
Mercer Rubber Co	108
Mesta Machine Co	158
Michigan Lubricator Co	114
Miller Improved Gas Engine Co	152
Minneapolis Steel and Machinery Co	162
Monarch Steam Blower Co	149
Moore & Co., Chas. C	149
Morehead Mfg. Co	99
Morrin Climax Boiler Co	149
Morris Machine Works	144
Morse, R. F	129
Mound Tool and Scraper Co	125
Murphy Iron Works	136
Murray Iron Works Co	164
Myers & Bro., F. E	145
Nason Mfg. Co	98
National India Rubber Co	108
National Pipe Bending Co	141
National Tube Co	129
Neemes Bros	137
Nelson Valve Co	121
New Bedford Boiler & Mach. Co	122
New Process Rawhide Co	83
New York & New Jersey Lubricant Co	112
New York Belting & Packing Co., Ltd	106
Northern Electrical Mfg. Co	153
Northern Engineering Wks	133
Nugent & Co., Wm. W	114
Ohio Blower Co	135
Ohio Brass Co	127
Ohio Injector Co	130
Otto Gas Engine Works	150
Parker Boiler Co	148
Patterson & Co., F. L	142
Peerless Rubber Mfg. Co	104
Penberthy Injector Co	131
Pennsylvania Flexible Metallic Tubing Co	102
Philips Pressed Steel Pulley Works	119
Phosphor Bronze Smelting Co	140
Pierce Co., Wm. B	2
Pittsburgh Gage & Supply Co	100
Pittsburgh Valve & Fittings Co	120
Pittsburg Valve, Foundry & Construction Co	122
Platt & Co., John	98
Powell Co., Wm	123
Power & Mining Machinery Co	152
Power Specialty Co	149
Prescott Steam Pump Co., Fred M	144
Providence Engineering Wks	157
Quaker City Rubber Co	4
Randle Machinery Co	103
Reeves Engine and Machine Co	154
Reliable Water Gauge Co	129
Reliance Gauge Column Co	128
Restein Co., Clement	107
Rhoads & Sons, J. E	117
Ridgway Dynamo & Engine Co	155
Riverside Engine Co	152
Robertson & Sons, Jas. L	101
Robins New Conveyor Co	119
Rollins Engine Co	160
Russell Engine Co	156
Rust Boiler Co	148
St. John, G. C	98
St. Louis Iron & Mach. Wks	156
Safety Equipment Mfg. Co	149
Salamander Grate Bar Co	136
Sargent Steam Meter Co	152
Sayen, Osgood	111
Scaife & Sons Co., Wm. B	134
Schaeffer & Budenberg Mfg. Co	101
Schieren Co., Chas. A	85
Schutte & Koerting Co	146
Scully Steel & Iron Co	134
Shepherd Engineering Co	154
Sherwood Mfg. Co	130
Shultz Belting Co	118
Sight Feed Oil Pump Co	113
Simplex Engineering Co	129
Sims Co	142
Sirocco Engineering Co	96
Skinner Engine Co	154
Smooth-On Mfg. Co	6
Star Brass Mfg. Co	101
Starrett Co., L. S	114
Steel Mill Packing Co	102
Stephenson Mfg. Co	83
Sterling Blower & Pipe Mfg. Co	134
Sterling Lubricator Co	114
Stewart Heater Co	143
Stocker, Geo. J	146
Stow Mfg. Co	153
Strong, Carlisle & Hammond Co	97
Struthers-Wells Co	150
Sturtevant Co., B. F	161
Thacher & Co., Geo. H	140
Toledo Pipe Threading Mach. Co	125
Trill Indicator Co	101
Trimont Mfg. Co	96
Tripp Metallic Packing Co	111
Triumph Electric Co	153
Tudor Boiler Mfg. Co	148
Underwood & Co., H. B	160
Vilter Mfg. Co	161
Vogt Machine Co., Henry	147
Walch & Wyeth	125
Walton Co., F. S	118
Warren Steam Pump Co	146
Watertown Engine Co	154
Watson & McDaniel Co	150
Webster & Co., Warren	91
Westinghouse Machine Co	138
Wheeler Condenser & Eng. Co	144
Whitlock Coil Pipe Co	143
Wickes Boiler Co	147
Wickes Bros	145
Wilcox Mfg. Co., E. A	102
Wilkinson Mfg. Co	140
Williams & Co., J. H	122
Williams Foundry & Machine Co	130
Wing Mfg. Co., L. J	103
Wright Mfg. Co	98
York Mfg. Co	122

Classified Index to Articles Advertised

Ammonia Fittings

Safety Equipment and Mfg. Co., Chicago, Ill.
York Mfg. Co., York, Pa.

Alarms, High and Low Water

Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Reliance Gauge Column Co., Cleveland, O.
Wright Mfg. Co., Detroit, Mich.

Arch, Back Combustion Chamber

Mayville Specialty Mfg. Co., Mayville, Wis.
McLeod & Henry Co., Troy, N. Y.

Asbestos Materials

Carey Co., Philip, Cincinnati, O.

Bars, Cylinder Boring

Mathews, Hugh, Kansas City, Mo.
Underwood & Co., H. B., Philadelphia, Pa.

Ball Bearings

Chapman Ball Bearing Co., Boston, Mass.

Belt Dressing and Fillers

Cling-Surface Co., Buffalo, N. Y.
Garlock Packing Co., Palymra, N. Y.
Harris Oil Co., A. W., Providence, R. I.
Johnson Co., Henry, Jersey City, N. J.
Keystone Lubricating Co., Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Stephenson Mfg. Co., Albany, N. Y.
Walton Co., F. S., Phila., Pa.

Belt Fasteners

Bristol Co., Waterbury, Conn.

Belting

Bowers Rubber Works, San Francisco, Cal.
Gandy Belting Co., Baltimore, Md.

Belting—*Continued.*

Garlock Packing Co., Palmyra, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Johnson Co., Henry, Jersey City N. J.
Laminated Belting Co., New York.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa.
Robins New Conveyor Co., New York.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Shifter

Mason Regulator Co., Boston, Mass.

Bending

Ball & Wood Co., Elizabethport, N. J.

Bends, Wrought Iron Pipe

Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Blast Dampers

Green Fuel Economizer Co., Matteawan, N. Y.

Blowers

De Laval Steam Turbine Co., Trenton, N. J.
Green Fuel Economizer Co., Matteawan, N. Y
Ohio Blower Co., Cleveland, O.
Scully Steel & Iron Co., Chicago, Ill.
Sirocco Engineering Co., New York
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.

Blowers, Steam Jet

McClave-Brooks Co., Scranton, Pa.
Monarch Steam Blower Co., Troy, N. Y.
Schutte & Koerting Co., Philadelphia, Pa.

Waiting to see water injure Schieren's DUXBAK LEATHER BELTING is an endless job; for there's not the slightest chance that such a thing could happen.

Father Time had better wake up to that fact and meander around with his eyes wide open. Then he'll come across many Duxbak Belts running in places where no other belt could do their work.

Chas. A. Schieren Company
ESTABLISHED 1868.

Tanners,
Belt Manufacturers

69 Cliff Street, New York

Chicago, 84-86-88 Franklin St.
Pittsburg, 240 Third Ave.
Hamburg, Germany, Auf dem Sande 1.

Boston, 186-188 Lincoln St.
Denver, 1622 Wazee St.

Philadelphia, 226 North Third St.
Brooklyn, N. Y., 13th St. and 3rd Ave.
OAK LEATHER TANNERIES, Bristol, Tenn.

Blow Piping
Ohio Blower Co., Cleveland, O.

Blue Print Machines
Buckeye Engine Co., Salem, O.

Boiler Cleaners, Automatic
Buckeye Boiler Skimmer Co., Toledo, Ohio.

Boiler Door Arches
McLeod & Henry Co., Troy, N. Y.
Mayville Specialty Mfg. Co., Mayville, Wis.

Boiler Fittings
Lunkenheimer Co., Cincinnati, O.
National Tube Co., Pittsburg, Pa.
Ohio Brass Co., Mansfield, Ohio.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Boiler Inspection
Fidelity & Casualty Co., New York.

Boiler Insurance
Fidelity & Casualty Co., New York.

Boiler Setting
McLeod & Henry Co., Troy, N. Y.

Boiler Tube Protector
Cruise & Co., Elizabeth, N. J.

Boiler Tubes, Welded and Seamless
National Tube Co., Pittsburg, Pa.

Boilers
Babcock & Wilcox Co., New York.
Beggs & Co., James, New York.
Bigelow Co., New Haven, Conn.
Griffith & Wedge Co., Zanesville, Ohio.
Harrisburg Foundry & Mach. Works, Harrisburg, Pa.
Harrison Safety Boiler Works, Philadelphia, Pa.
Heine Safety Boiler Co., St. Louis, Mo.
Hewes & Phillips Iron Works, Newark, N. J.
Keeler Co., E., Williamsport, Pa.
Kewanee Boiler Co., Kewanee, Ill.
Minn. Steel and Machinery Co., Minneapolis, Minn.
Morrin Climax Boiler Co., Brooklyn, N. Y.
Murray Iron Works Co., Burlington, Iowa.
New Bedford Boiler & Mach. Co., New Bedford, Mass.
Parker Boiler Co., Philadelphia, Pa.
Rust Boiler Co., Pittsburg, Pa.
Struthers-Wells Co., Warren, Pa.
Tudor Boiler Mfg. Co., Cincinnati, O.
Vogt Machine Co., Henry, Louisville, Ky.
Wickes Boiler Co., Saginaw, Mich.
York Mfg. Co., York, Pa.

Books, Technical
Hill Publishing Co., New York.
International Correspond. Schools, Scranton, Pa.

Braces, Boiler
Scully Steel & Iron Co., Chicago, Ill.

Brick, Chrome
Harbison-Walker Refractories Co., Pittsburg, Pa.

Brick, Fire Clay
Harbison-Walker Refractories Co., Pittsburg, Pa.
McLeod & Henry Co., Troy, N. Y.

Brick, Magnesia
Harbison-Walker Refractories Co., Pittsburg, Pa.

Brick, Silicia
Harbison-Walker Refractories Co., Pittsburg, Pa.

Calorimeters
Sargent Steam Meter Co., Chicago, Ill.
Schaeffer & Budenberg Mfg Co., Foxboro, Mass.

Castings, Brass and Iron
McClave-Brooks Co., Scranton, Pa.
Neemes Bros., Troy, N. Y.
Ohio Brass Co., Mansfield, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Salamander Grate Bar Co., New York.

Castings, Steel
Mesta Machine Co., Pittsburg, Pa.
Minneapolis Steel and Mchy. Co., Minneapolis, Minn.

Cement, Asbestos
Carey Co., Philip, Cincinnati, O.

Cement, Boiler
Smooth-On Mfg. Co., Jersey City, N. J.

Cement, Belt
Rhoads & Sons, J. E., Phila., Pa.

Cement, Iron
Smooth-On Mfg. Co., Jersey City, N. J.

Cement Machinery
Power & Mining Machinery Co., Cudahy, Wis.

Cement, Rubber
Peerless Rubber Mfg. Co., New York.

Chambers, Air
Hercules Float Works, Springfield, Mass.

Clamp, Pipe
McCrea & Co., James, Chicago, Ill.
Simplex Engineering Co., Philadelphia, Pa.

Cleaners, Boiler Tube
Cleveland Flue Cleaner Mfg. Co., Cleveland, Ohio.
Garlock Packing Co., Palmyra, N. Y.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Monarch Steam Blower Co., Troy, N. Y.
Pierce Co., Wm. B., Buffalo, N. Y.
Robertson & Sons, Jas. L., New York.
Scully Steel & Iron Co., Chicago, Ill.
Stephenson Mfg. Co., Albany, N. Y.
St. John, G. C., New York.
Stewart Heater Co., Buffalo, N. Y.

Cleaners, Mechanical
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Pierce Co., Wm. B., Buffalo, N. Y.
Scully Steel & Iron Co., Chicago, Ill.

Cling-Surface
See Belt Dressing.

Clutches, Coupling
Williams Foundry and Machine Co., Akron, Ohio.

Clutches, Friction
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Williams Foundry & Machine Co., Akron, Ohio.

Coal and Ash Handling Machinery
Jeffrey Mfg. Co., Columbus, O.
Northern Engineering Works, Detroit, Mich.

Cocks, Gauge
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Huyette Co., Paul B., Philadelphia, Pa.
Jerguson Mfg. Co., Boston, Mass.
Ohio Brass Co., Mansfield, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Reliance Gauge Column Co., Cleveland, O.
Schæffer & Budenberg Mfg. Co., Foxboro, Mass.
Wright Mfg. Co., Detroit, Mich.

Cocks, Steam
Dart Mfg. Co., E. M., Prov., R. I.
Homestead Valve Mfg. Co., Pittsburg, Pa.
Huxley Valve Co., Buffalo, N. Y.
Lunkenheimer Co., Cincinnati, O.
National Tube Co., Pittsburg, Pa.

Compound, Boiler
Binghamton Boiler Compound Co., Binghamton, N. Y.
Bird-Archer Co., New York.
Dearborn Drug & Chemical Works, Chicago, Ill.
Harris Oil Co., A. W., Providence, R. I.
Hawk-Eye Compound Co., Chicago, Ill.

Compound, Boiler—*Continued*
Johnson Co., Henry, Jersey City, N. J.
Keystone Lubricating Co., Philadelphia, Pa.
Lord Co., Geo. W., Phila., Pa.
Stephenson Mfg. Co., Albany, N. Y.

Compound, Commutator
Dixon Crucible Co., Jos., Jersey City, N. J.
McLennan & Co., K., Chicago, Ill.

Compound, Lubricating
Cook's Sons, Adam, New York.

Compressors, Air
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Murray Iron Works Co., Burlington, Iowa.

Condensers
Alberger Condenser Co., New York.
Anderson Co., V. D., Cleveland, O.
Baragwanath & Son, Wm., Chicago, Ill.
Blake Pump and Condenser Co., Fitchburg, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Bulkley, Henry W., Orange, N. J.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Mesta Machine Co., Pittsburg, Pa.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Prescott Steam Pump Co., F. M., Milwaukee, Wis.
Schutte & Koerting Co., Philadelphia, Pa.
Stewart Heater Co., Buffalo, N. Y.
Warren Steam Pump Co., Warren, Mass.
Wheeler Condenser and Engineering Co., New York.

Consumers, Smoke
Griscom-Spencer Co., New York.
Climax Smoke Preventer Co., Boston, Mass.

Controllers, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Controllers, Feed Water
American Boiler Economy Co., Philadelphia, Pa.
Strong, Carlisle & Hammond Co., Cleveland, O.

Cooling Towers
Alberger Condenser Co., New York.
Stocker, Geo. J., St. Louis, Mo.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Coverings, Pipe and Boiler
Carey Co., Philip, Cincinnati, O.
Keasbey Co., Robt. A., New York.

Cranes
Northern Engineering Works, Detroit, Mich.

Crank Pin Turning Machine
Underwood & Co., H. B., Philadelphia, Pa.

Cupolas, Foundry
Bigelow Co., New Haven, Conn.

Cylinders, Irrigation
Myers & Bro., F. E., Ashland, O.

Die Stocks
Crane Co., Chicago, Ill.
Curtis & Curtis Co., Bridgeport, Conn

Draft Apparatus, Forced
Green Fuel Economizer Co., Matteawan, N. Y.
Sirocco Engineering Co., New York.

Drills, Upright
Barnes Co., W. F. & John, Rockford, Ill.

Dry Kiln Equipment
Green Fuel Economizer Co., Matteawan, N. Y.
Ohio Blower Co., Cleveland, O.

Dryers
Bigelow, Co., New Haven, Conn.

Dust Collectors
Buffalo Forge Co., Buffalo, N. Y.
Green Fuel Economizer Co., Matteawan, N. Y.
Ohio Blower Co., Cleveland, O.

Economizers, Fuel
Green Fuel Economizer Co., Matteawan, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Educational
International Correspondence Schools, Scranton, Pa.

Ejectors
American Injector Co., Detroit, Mich.
Desmond-Stephan Mfg. Co., Urbana, Ohio.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Penberthy Injector Co., Detroit, Mich.
Schæffer & Budenberg Mfg. Co., Foxboro, Mass.

Electrical Machinery and Supplies
American Engine Co., Bound Brook, N. J.
Bristol Co., Waterbury, Conn.
General Electric Co., Schenectady, N. Y.
Griscom-Spencer Co., New York.
Ohio Brass Co., Mansfield, O.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Elevators and Conveyors
Jeffrey Mfg. Co., Columbus, Ohio.

Engineers, Consulting and Contracting
Moore & Co., Chas. C., San Francisco, Cal.

Engine Stops
Strong, Carlisle & Hammond Co., Cleveland, O.

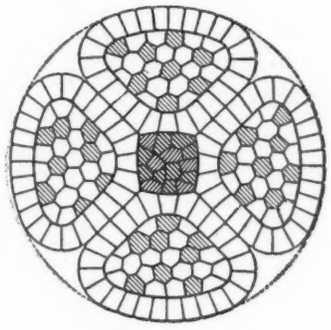
Engines, Gas and Gasolene
Ajax Iron Works, Corry, Pa.
Alberger Co., A. H., Buffalo, N. Y.
American & British Mfg. Co., Providence, R. I.
Beggs & Co., James, New York.
Bruce-Meriam-Abbott Co., Cleveland, O.
Buckeye Engine Co., Salem, O.
De La Vergne Mach. Co., New York.
Du Bois Iron Works, Du Bois, Pa.
Foos Gas Engine Co., Springfield, Ohio.
Mesta Machine Co., Pittsburg, Pa.
Miller Improved Gas Engine Co., Springfield, O.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Otto Gas Engine Works, Philadelphia, Pa.
Struthers-Wells Co., Warren, Pa.
Westinghouse Mach. Co., Pittsburg, Pa.

Engines, Oil
American & British Mfg. Co., Providence, R. I.
American Diesel Engine Co., New York.
De La Vergne Mach. Co., New York.
Du Bois Iron Works, Du Bois, Pa.

Engines, Rotary
Ball-Cooley Engr. Co., New York.

Engines, Steam
American Engine Co., Bound Brook, N. J.
American & British Mfg. Co., Providence, R. I.
Ball Engine Co., Erie, Pa.
Ball & Wood Co., Elizabethport, N. J.
Bass Foundry & Mach. Co., Fort Wayne, Ind.
Beggs & Co., James, New York.
Brown Engine Co., C. H., Fitchburg, Mass.
Buckeye Engine Co., Salem, O.
Buffalo Forge Co., Buffalo, N. Y.
Chuse Engine & Mfg. Co., Mattoon, Ill.
Clark Bros. Co., Belmont, N. Y.
Cooper Co., C. & G., Mt. Vernon, Ohio.
De La Vergne Mach. Co., New York.
Erie Mfg. & Supply Co., Erie, Pa.

"AMERICAN"

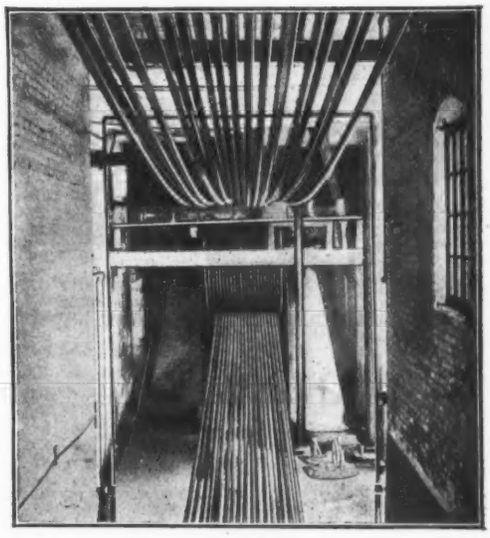


"Like Smooth Rods of Iron"

"American" Transmission Rope in service soon assumes an almost perfectly rounded smooth surface. The graphite lubricant with which the internal yarns and core are saturated, permeates every fibre, facilitating the compression of the strands until the rope becomes smooth and round and presents the greatest area of contact to the sheave groove.

"American" Ropes are designed to turn in their grooves keeping the rope round and smooth and the grooves of the sheaves perfectly true.

If you desire complete information regarding the advantages of rope driving and "American" Transmission Rope, write for a copy of our "Blue Book of Rope Transmission." Copies free.



The American Manufacturing Co.,

123 65 Wall Street, New York City.

TRANSMISSION ROPE

Engines, Steam—*Continued.*
Fishkill Landing Machine Co., Fishkill-on-the-Hudson, N. Y.
Fitchburg Steam Engine Co., Fitchburg, Mass.
Fulton Iron Works, St. Louis, Mo.
Green Fuel Economizer Co., Matteawan, N. Y.
Greenfield, Steam Engine Works, Harrison, N. J.
Griffith & Wedge Co., Zanesville, O.
Griscom-Spencer Co., New York.
Harrisburg Fdry. & Mach. Works, Harrisburg, Pa.
Harris Steam Engine Co., Wm., A., Providence, R. I.
Hewes & Phillips Iron Works, Newark, N. J.
Ide & Son, A. L., Springfield, Ill.
McIntosh, Seymour & Co., Auburn, N. Y.
Mesta Machine Co., Pittsburg, Pa.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Morris Machine Works, Baldwinsville, N. Y.
Murray Iron Works Co., Burlington, Iowa.
Providence Engr. Works, Providence, R. I.
Reeves Engine & Machine Co., Trenton, N. J.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Riverside Engine Co., Oil City, Pa.
Rollins Engine Co., Nashua, N. H.
Russell Engine Co., Massillon, O.
St. Louis Iron & Mach. Works, St. Louis, Mo.
Skinner Engine Co., Erie, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Vilter Mfg. Co., Milwaukee, Wis.
Watertown Engine Co., Watertown, N. Y.
Westinghouse Mach. Co., Pittsburg, Pa.
York Mfg. Co., York, Pa.

Exhaust Heads
Burt Mfg. Co., Akron, O.
Direct Separator Co., Syracuse, N. Y.
Gardner Governor & Separator Co., Quincy, Ill.
Hoppes Mfg. Co., Springfield, O.
Loew Mfg. Co., Cleveland, O.
Ohio Blower Co., Cleveland, O.
Patterson & Co., Frank L., New York.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Robertson & Sons, Jas. L., New York.
Sims Co., Erie, Pa.
Sterling Blower & Pipe Mfg. Co., Hartford, Conn.
Sturtevant Co., B. F., Hyde Park, Mass.
Whitlock Coil Pipe Co., Hartford, Conn.
Wright Mfg. Co., Detroit, Mich.

Exhausters, Gas
Green Fuel Economizer Co., Matteawan, N. Y.
Ohio Blower Co., Cleveland, O.

Fans, Electric
General Electric Co., Schenectady, N. Y.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.
Wing Mfg. Co., L. J., New York.

Fans, Exhaust
Anderson Co., V. D., Cleveland, O.
Buffalo Forge Co., Buffalo, N. Y.
Green Fuel Economizer Co., Matteawan, N. Y.
Wing Mfg. Co., L. J., New York.

Feeders, Boiler
American Boiler Economy Co,, Philadelphia, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

Feeders, Furnace
Ohio Blower Co., Cleveland, O.
Sterling Blower & Pipe Mfg. Co., Hartford, Conn.

Feed Water Heaters and Purifiers
Alberger Condenser Co., New York.
Baragwanath & Son, Wm., Chicago, Ill.
Beggs & Co., James, New York.
Erie Mfg. & Supply Co., Erie, Pa.
Green Fuel Economizer Co., Matteawan, N. Y.
Griscom-Spencer Co., New York.
Harrison Safety Boiler Works, Philadelphia, Pa.

Feed Water Heaters and Purifiers—*Continued.*
Hoppes Mfg. Co., Springfield, O.
Kewanee Boiler Co., Kewanee, Ill.
Loew Mfg. Co., Cleveland, O.
Marion Incline Filter and Heater Co., Marion, O.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Murray Iron Works Co., Burlington, Iowa.
National Pipe Bending Co., New Haven, Conn.
Patterson & Co., Frank L., New York.
Robertson & Sons, Jas. L., New York,
Sims Co., Erie, Pa.
Stewart Heater Co., Buffalo, N. Y.
Tudor Boiler Mfg. Co., Cincinnati, O.
Webster & Co., Warren, Camden, N. J.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

Filters, Oil
Beggs & Co., James, New York.
Burt Mfg. Co., Akron, O.
Flower Steam Specialty Co., Walter L., St. Louis, Mo.
Liberty Mfg. Co., Pittsburg, Pa.
Robertson & Sons, Jas. L., New York.
Sims Co., Erie, Pa.
Wright Mfg. Co., Detroit, Mich.

Firebox Blocks
McLeod & Henry Co., Troy, N. Y.

Flanges
Ball & Wood Co., Elizabethport, N. J.
Central Station Steam Co., Detroit, Mich.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Jefferson Union Co., Lexington, Mass.

Flanges, Forged Steel
American Spiral Pipe Works, Chicago, Ill.

Flexible Shafts
Stow Mfg. Co., Binghamton, N. Y.

Floats
Anderson Co., V. D., Cleveland, Ohio.
Hercules Float Works, Springfield, Mass.
Reliance Gauge Column Co., Cleveland, Ohio.

Floor Stands
Chapman Valve Mfg. Co., Indian Orchard, Mass.

Flue Cleaners
See Cleaners, Boiler Tube.

Forges
Buffalo Forge Co., Buffalo, N. Y.
Wing Mfg. Co., L. J., New York.

Forgings, Drop
Williams & Co., J. H., Brooklyn, N. Y.

Forgings, Iron and Steel
Griscom-Spencer Co., New York.

Furnaces, Annealing
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

Furnaces, Forging
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

Furnaces, Hardening
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

Furnaces, Melting
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

Furnaces, Smokeless
McClave-Brooks Co., Scranton, Pa.
Murphy Iron Works, Detroit, Mich.
Wilkinson Mfg. Co., Bridgeport, Pa.

Furnaces, Tempering
Strong, Carlisle & Hammond Co., Cleveland, Ohio.

Gaskets
American Goetze Gasket & Packing Co., New York.
Carey Co., Philip, Cincinnati, O.

Gaskets—*Continued.*
Detroit Leather Specialty Co., Detroit, Mich.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Keeler Co., E., Williamsport, Pa.
Mechanical Rubber Co., Cleveland, O.
National India Rubber Co., Bristol, R. I.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Wilcox Mfg. Co., E. A., Chicago, Ill.

Gaskets, Copper
American Goetze Gasket & Packing Co., New York.
Central Station Steam Co., Detroit, Mich.

Gaskets, Leather
Detroit Leather Specialty Co., Detroit, Mich.

Gaskets, Water Gauge
Johnson Co., Henry, Jersey City, N. J.
Morse, R. F., Providence, R. I.

Gauge Glasses
Garlock Packing Co., Palmyra, N. Y,
Johnson Co., Henry, Jersey City. N. J.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Sterling Lubricator Co., Rochester, N. Y.
Webster & Co., Warren, Camden, N. J.

Gauge Testing Outfit
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Gauges, Ammonia
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Gauges, Draft
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bristol Co., Waterbury, Conn.
Sargent Steam Meter Co., Chicago, Ill.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Gauges, Pressure
American Steam Gauge and Valve Mfg. Co., Boston, Mass.
Crosby Steam Gage & Valve Co., Boston, Mass.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Webster & Co., Warren, Camden, N. J.

Gauges, Recording
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Bristol Co., Waterbury, Conn.
Ohio Injector Co., Wadsworth, Ohio.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Gauges, Vacuum
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Gauges, Water
Greene, Tweed & Co., New York.
Huyette Co., Paul B., Philadelphia, Pa.
Jerguson Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Ohio Brass Co., Mansfield Ohio.
Reliable Water Gauge Co., St. Louis, Mo.
Reliance Gauge Column Co., Cleveland, O.
Safety Equipment Mfg. Co., Chicago, Ill.
Wright Mfg. Co., Detroit, Mich.

Gears
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
New Process Raw Hide Co., Syracuse, N. Y.

Generating Sets
American Engine Co., Bound Brook, N. J.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Electric Co., Cincinnati, Ohio.

Governors, Inertia
Ide & Son, A. L., Springfield, Ill.

Governors, Pump
American Boiler Economy Co., Philadelphia, Pa.
Berry Engineering Co., Chester, Pa.
Chaplin-Fulton Mfg. Co., Pittsburg, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
Davis Co., John, Chicago, Ill.
Gardner Governor & Separator Co., Quincy, Ill.
Mason Regulator Co., Boston, Mass.
Safety Equipment Mfg. Co., Chicago, Ill.
Strong, Carlisle & Hammond Co., Cleveland, O.
Webster & Co., Warren, Camden, N. J.

Graphite
Garlock Packing Co., Palmyra, N. Y.
Johnson Co., Henry, Jersey City, N. J.

Grates, Chain Traveling
Green Engineering Co., Chicago, Ill.

Grates, Clinker Cutting
McClave-Brooks Co., Scranton, Pa.
Neemes Bros., Troy, N. Y.

Grates, Dumping
Beggs & Co., James, New York.
Kelly Foundry & Machine Co., Goshen, Ind.
Martin Grate Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Neemes Bros., Troy, N. Y.
Salamander Grate Bar Co., New York.
Thacher & Co., George H., Albany, N. Y.

Grates, Shaking
Kelly Foundry & Machine Co., Goshen, Ind.
McClave-Brooks Co., Scranton, Pa.
Neemes Bros., Troy, N. Y.
Robertson & Sons, Jas. L., New York.
Salamander Grate Bar Co., New York.
Thacher & Co., George H., Albany, N. Y.

Grates, Shaking & Dumping
Kelly Foundry & Machine Co., Goshen, Ind.
McClave-Brooks Co., Scranton, Pa.
Neemes Bros., Troy, N. Y.
Salamander Grate Bar Co., New York.

Grates, Stationary
Kelly Foundry & Machine Co., Goshen, Ind.
Neemes Bros., Troy, N. Y.
Salamander Grate Bar Co., New York.

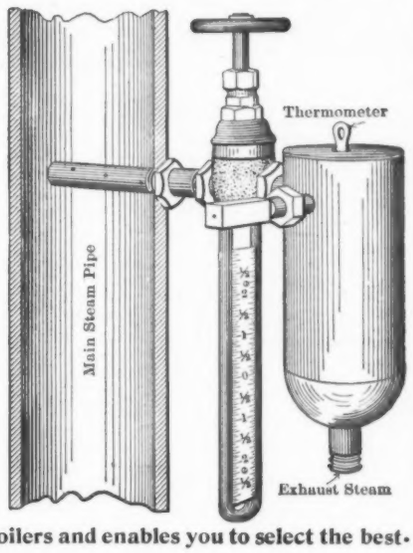
Grease
Cook's Sons, Adam, New York.
Dixon Crucible Co., Jos., Jersey City, N. J.
Harris Oil Co., A. W., Providence, R. I.
Kellogg & Co., E. H., New York.
Keystone Lubricating Co., Philadelphia, Pa.
N. Y. & N. J. Lubricant Co., New York.

Grease Extractors
Beggs & Co., James, New York.
Griscom-Spencer Co., New York.
Hussey, McCann & Co., New York.

Heaters, Feed Water
See Feed Water Heaters and Purifiers.

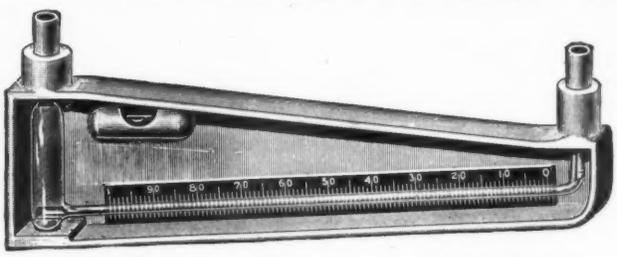
THE AMERICAN

ELLISON-CALORIMETER Determines The Amount Of Moisture In Steam, And Shows



The amount of loss due to condensation in long pipes.
The condensation saved by covering steam pipes.
The quality of steam furnished by your present boilers.
The advisability of installing a steam separator.
The efficiency of the separator when put in.
The comparative dryness of the steam furnished by the different types of boilers and enables you to select the best.
Write for circular 81-D.

The American-Ellison Differential Draft Gauge.



The Only Accurate Draft Gauge On The Market.

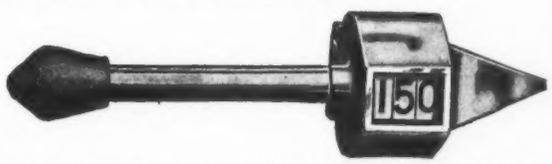
Indispensable where the economical combustion of fuel is required.

A knowledge of the exact draft in the chimney and combustion chamber and the quantity of air furnished the fuel for combustion is one of the most essential factors in the economical and successful running of a steam plant.

Indorsed by consulting engineers, boiler manufacturers, and engineers in general. Circular 82-D describes it.

A Speed Counter For The Vest Pocket.

Will Not clog or heat. Reads right or left.



The arrow point, applied to center of arbor shaft, removes all dirt and oil. Take initial reading, hold the counter by the arrow point and apply rubber tip to center of arbor or shaft, deduct initial reading from final result, which will give the number of revolutions. Write for circular V-D.

The AMERICAN Gauges, Valves, Indicators and Kindred appliances for governing, indicating, measuring, recording and controlling steam, air, gas, oil, ammonia and all other pressures, are noted for their accuracy and durability. If you want the BEST get THE AMERICAN.

American Steam Gauge & Valve Mfg. Co.,

208-220 Camden Street, Boston, Mass.

New York, 26 Cortlandt St. Atlanta, 853 Equitable Bldg. Chicago, 7-9 So. Jefferson St.

Pittsburg, Frick Bldg. Annex. San Francisco, 247 Pine Street.
Montreal, 444 St. James Street. Los Angeles, 213 So. Angeles Street.

Heating and Ventilating System
Buffalo Forge Co., Buffalo, N. Y.
Green Fuel Economizer Co., Matteawan, N. Y.
Ohio Blower Co., Cleveland, O.
Sturtevant Co., B. F., Hyde Park, Mass.
Webster & Co., Warren, Camden, N. J.
Wing Mfg. Co., L. J., New York.

Hoists
Northern Engineering Works, Detroit, Mich.

Hose
Bowers Rubber Works, San Francisco, Cal.
Garlock Packing Co., Palmyra, N. Y.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Lagonda Mfg. Co., Springfield, O.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
Myers & Bro., F. E., Ashland, O.
New York Belting & Packing Co., New York.
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa.

Hose, Air
Restein Co., Clement, Philadelphia, Pa.

Hose, Oil
Restein Co., Clement, Philadelphia, Pa.

Hose, Steam
Restein Co., Clement, Philadelphia, Pa.

Hose, Water
Restein Co., Clement, Philadelphia, Pa.

Indicators, Gas Engine
American Steam Gauge & Valve Mfg. Co., Boston, Mass.

Indicators, Speed
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Starrett Co., L. S., Athol, Mass.

Indicators, Steam Engine
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Crosby Steam Gage & Valve Co., Boston, Mass.
Lippincott Steam Specialty & Supply Co., Newark, N. J.
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Star Brass Mfg. Co., Boston, Mass.
Trill Indicator Co., Corry, Pa.

Injectors
American Injector Co., Detroit, Mich.
Desmond-Stephan Mfg. Co., Urbana, O.
Detroit Lubricator Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, O.
Ohio Injector Co., Wadsworth, O.
Penberthy Injector Co., Detroit, Mich.
Randle Machinery Co., Cincinnati, Ohio.
Robertson & Sons, Jas. L., New York.
Schutte & Koerting Co., Philadelphia, Pa.
Sherwood Mfg. Co., Buffalo, N. Y.

Joints, Expansion
Alberger Condenser Co., New York.
Central Station Steam Co., Detroit, Mich.
Webster & Co., Warren, Camden, N. J.

Joints, Pipe
McCrea & Co., James, Chicago, Ill.

Lamps, Arc
General Elec. Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Lamps, Incandescent
General Elec. Co., Schenectady, N. Y.
Ohio Brass Co., Mansfield, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Lathes, Foot Power
Barnes Co., W. F. & John, Rockford, Ill.

Leather, Lace
Rhoads & Sons, J. E., Phila., Pa.
Schieren Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Lubricants
Cook's Sons, Adam, New York.
N. Y. & N. J. Lubricant Co., New York.

Lubricating and Oiling Devices
Lunkenheimer Co., Cincinnati, O.
Nugent & Co., W. W., Chicago, Ill.

Lubricators
Cook's Sons, Adam, New York.
Detroit Lubricator Co., Detroit, Mich.
Greene, Tweed & Co., New York.
Griscom-Spencer Co., New York.
Lunkenheimer Co., Cincinnati, O.
Manzel Bros. Co., Buffalo, N. Y.
Michigan Lubricator Co., Detroit, Mich.
Ohio Injector Co., Wadsworth, O.
Powell Co., Wm., Cincinnati, O.
Robertson & Sons, Jas. L., New York.
Sherwood Mfg. Co., Buffalo, N. Y.
Sight Feed Oil Pump Co., Milwaukee, Wis.
Stephenson Mfg. Co., Albany, N. Y.
Sterling Lubricator Co., Rochester, N. Y.

Machines, Ice
Vilter Mfg. Co., Milwaukee, Wis.

Machines, Pipe Cutting and Threading
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Crane Co., Chicago, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Loew Mfg. Co., Cleveland, O.
Toledo Pipe Threading Machine Co., Toledo, Ohio.
Trimont Mfg. Co., Roxbury, Mass.

Machinery, Second Hand
Hewes & Phillips Iron Works, Newark, N. J.
Ludlow, M. B., New Orleans, La.
Randle Machinery Co., Cincinnati, Ohio.
Wickes Bros., Saginaw, Mich.

Machinists, General
American & British Mfg. Co., Providence, R. I.
Bruce-Meriam-Abbott Co., Cleveland, O.
Mathews, Hugh, Kansas City, Mo.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Providence Engineering Works, Providence, R. I.

Mats & Matting, Rubber
Home Rubber Co., Trenton, N. J.
Mercer Rubber Co., Hamilton Square, N. J.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.

Mechanical Draft
Buffalo Forge Co., Buffalo, N. Y.
Green Fuel Economizer Co., Matteawan, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Wing Mfg. Co., L. J., New York.

Metal, Anti-Friction
Allan & Son, A., New York.

Metals, Bearing
Allan & Son, A., New York.
Phosphor Bronze Smelting Co., Ltd., Philadelphia, Pa.

Metal Polish
Hoffman, Geo. W., Indianapolis, Ind.

Meters, Steam
Sargent Steam Meter Co., Chicago, Ill.
St. John, G. C., New York.

Micrometers
Starrett Co., L. S., Athol, Mass.

Milling Machines, Portable
Underwood & Co., H. B., Philadelphia, Pa.

Mill Supplies
Quaker City Rubber Co., Philadelphia, Pa.

Mining and Smelting Machinery
Moore & Co., Chas. C., San Francisco, Cal.

Motors and Dynamos
American Engine Co., Bound Brook, N. J.
Clark Bros. Co., Belmont, N. Y.
General Elec. Co., Schenectady, N. Y.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Stow Mfg. Co., Binghamton, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincinnati, Ohio.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Motors, Water
Lagonda Mfg. Co., Springfield, O.

Nipples
National Tube Co., Pittsburg, Pa.

Oil and Grease Cups
American Injector Co., Detroit, Mich.
Cook's Sons, Adam, New York.
Griscom-Spencer Co., New York.
Keystone Lubricating Co., Philadelphia, Pa.
Liberty Mfg. Co., Pittsburg, Pa.
Lunkenheimer Co., Cincinnati, O.
Powell Co., Wm., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Sherwood Mfg. Co., Buffalo, N. Y.

Oil Burners
Hammel Oil Burner Co., Los Angeles, Cal.

Oil Dash Pots
Lammert & Mann, Chicago, Ill.

Oil Reservoirs
Burt Mfg. Co., Akron, O.

Oilers, Crank Pin
Penberthy Injector Co., Detroit, Mich.

Oiling Systems
Pittsburgh Gage & Supply Co., Pittsburg, Pa.

Oils
Cook's Sons, Adam, New York.
Dearborn Drug & Chemical Wks., Chicago, Ill.
Harris Oil Co., A. W., Providence, R. I.
Kellogg & Co., E. H., New York.
New York & New Jersey Lubricant Co., New York.

Oils, Non Fluid
N. Y. & N. J. Lubricant Co., New York.

Packing, Asbestos
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
Restein Co., Clement, Philadelphia, Pa.

Packing, Flange
Carey Co., Philip, Cincinnati, O.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
National India Rubber Co., Bristol, R. I.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Phila., Pa.
Robertson & Sons, Jas. L., New York.

Packing, Flange—*Continued.*
Smooth-On Mfg. Co., Jersey City, N. J.

Packing, Hydraulic
Brandt, Randolph, New York.
Detroit Leather Specialty Co., Detroit, Mich.
Garlock Packing Co., Palmyra, N. Y.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Robertson & Sons, Jas. L., New York.
Schieren Co., Chas. A., New York.

Packing, Metallic
American Huhn Metallic Packing Co., New York.
Bridgeport Metallic Packing Co., Bridgeport, Conn.
Garlock Packing Co., Palmyra, N. Y.
Houchin-Aiken Co., Brooklyn, N. Y.
Johnson Co., Henry, Jersey City, N. J.
Mercer Rubber Co., Hamilton Square, N. J.
Tripp Metallic Packing Co., Boston, Mass.

Packing, Piston
American Steam Packing Co., Boston, Mass.
Bowers Rubber Works, San Francisco, Cal.
Carey Co., Philip, Cincinnati, O.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
National India Rubber Co., Bristol, R. I.
New York Belting & Packing Co. New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Robertson & Sons, Jas. L., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Packing, Pneumatic
Detroit Leather Specialty Co., Detroit, Mich.
Mercer Rubber Co., Hamilton Square, N. J.

Packing, Pump Valve
Home Rubber Co., Trenton, N. J.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.

Packing, Rod
American Huhn Metallic Packing Co., New York.
Bowers Rubber Co., San Francisco, Cal.
Brandt, Randolph, New York.
Bridgeport Metallic Packing Co., Bridgeport, Conn.
Carey Co., Philip, Cincinnati, O.
Flower Steam Specialty Co., Walter L., St. Louis, Mo.
Garlock Packing Co., Palmyra, N. Y.
Greene, Tweed & Co., New York.
Home Rubber Co., Trenton, N. J.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
Mercer Rubber Co., Hamilton Square, N. J.
National India Rubber Co., Bristol, R. I.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Robertson & Sons, Jas. L., New York.
Sayen, Osgood, Philadelphia, Pa.
Steel Mill Packing Co., Detroit, Mich.

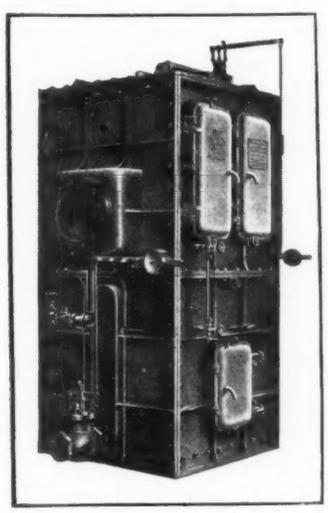
Packing, Valve Stem
Home Rubber Co., Trenton, N. J.
Mechanical Rubber Co., Cleveland, Ohio.
Mercer Rubber Co., Hamilton Square, N. J.
Quaker City Rubber Co., Philadelphia, Pa.

Websterizing

A Monthly Bulletin For Steam Engineers

VOL. 1. JULY, 1908. NO. 1.

It is our plan to use this space each month as a bulletin of interesting information for steam engineers. The men who are interested in the progress of steam economy will find it to their advantage to follow these columns.



By "Websterizing" we mean the application of Webster Methods and Specialties to the power plant—their operation, maintenance, efficiency and economy.

It takes more than an engine, a boiler, a coal pile and a water supply to make a power plant. They may be among the first essentials but they can't work for economy *alone*. It's the appliances that are added that keep things running smoothly and economically and make the engineer's life easy.

There must be a Feed-Water Heater and Purifier to keep the boiler fed with hot, pure water and to help the coal pile do its work.

There must be Steam and Oil Separators, made after the pattern best adapted to the particular needs of the plant.

There must be an efficient, economical heating system utilizing the waste exhaust steam, giving comfort, convenience and health at little or no expense for fuel.

All these appliances are necessary to highest economy, all work for better results in the power plant, and all of them are included in the line of Webster Steam Specialties and the Webster System of Steam Circulation.

Our engineers are ready to study the needs of your power plant, tell you which of the Specialties you need, why you need them and how they will save for you.

Highest possible efficiency and economy are guaranteed in a "Websterized" plant.

We are here to consult. Write us today for booklet 12-G.

* * *

In the economical operation of the modern power plant, the feed-water heater plays a small but highly important part, yet often but little careful thought is given to its selection.

It should be as carefully selected as your boiler, for upon its efficiency the steaming capacity of the latter largely depends.

A difference of even ten degrees in the temperature of the boiler feed will have an appreciable effect upon the amount of coal consumed or upon the horse-power developed.

You may be able to buy a good heater at a fair price, but a cheap one is dear at any price.

Suppose the Webster Heater cost $50 more than the cheapest heater and saves only two per cent. more fuel—how long will it take it to wipe out that $50 difference? Consider too that the extra two per cent. would continue after it had paid for itself.

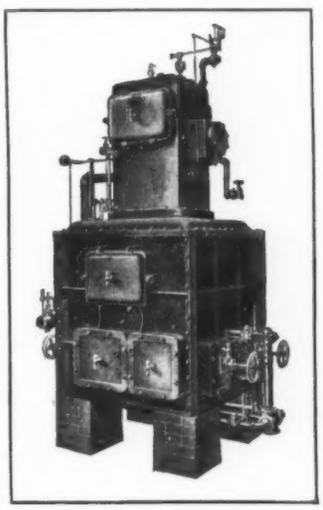
First cost is delusive—it's *value* that you want. Cost is what you pay—value is what you get.

Let us send you our heater booklet, 12-F.

* * *

The illustration below shows the Webster Chemical Purifier. It's built upon the right lines for treating water containing scale-forming elements. It treats the water *while hot*, and *before* it reaches the boilers. No locking the stable-door "after the horse is stolen." Scale simply cannot form in the boilers.

Booklet 12-C tells more.



Warren Webster & Co., Camden, N.J.

Pipe

Ball & Wood Co., Elizabethport, N. J.
Central Station Steam Co., Detroit, Mich.

Pipe, Riveted Steel

Minneapolis Steel & Mchy. Co., Minneapolis, Minn.

Pipe, Spiral

American Spiral Pipe Works, Chicago, Ill.

Pipe, Wrought

National Tube Co., Pittsburg, Pa.

Pipe Bending

Ball & Wood Co., Elizabethport, N. J.
National Pipe Bending Co., New Haven, Conn.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Whitlock Coil Pipe Co., Hartford, Conn.

Pipe Coils, Brass, Iron and Copper

McCrea & Co., James, Chicago, Ill.
National Pipe Bending Co., New Haven, Conn.
Whitlock Coil Pipe Co., Hartford, Conn.

Pipe Fittings

Best Mfg. Co., Pittsburg, Pa.
Crane Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
McCrea & Co., James, Chicago, Ill.
National Tube Co., Pittsburg, Pa.
Ohio Brass Co., Mansfield, Ohio.
Pittsburg Valve & Fittings Co., Pittsburg, Pa.
Pittsburg Valve, Foundry and Construction Co., Pittsburg, Pa.
Trimont Mfg. Co., Roxbury, Mass.

Pipe Joints, Compound

Dixon Crucible Co., Jos., Jersey City, N. J.

Planimeters

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Lippincott Steam Specialty & Supply Co., Newark, N. J.
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Plumbago

Dixon Crucible Co., Jos., Jersey City, N. J.

Power Plant Supplies

Safety Equipment Mfg. Co., Chicago, Ill.

Preventers, Smoke

Climax Smoke Preventer Co., Boston, Mass.

Producers, Gas

Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Power & Mining Mach. Co., Cudahy, Wis.

Publishers

Hill Publishing Co., New York.
International Corresp. Schools, Scranton, Pa.

Pulleys

American Pulley Co., Phila., Pa.
Dodge Mfg. Co., Mishawaka, Ind.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Philips Pressed Steel Pulley Works, Philadelphia, Pa.

Pulleys, Clutch

Williams Foundry & Mach. Co., Akron, Ohio.

Pumps, Air

Dean Bros. Steam Pump Works, Indianapolis, Ind.
Du Bois Iron Works, Du Bois, Pa.
Goulds Mfg. Co., Seneca Falls, N. Y.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Prescott Steam Pump Co., F. M., Milwaukee, Wis.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Pumps, Boiler Feed

Kewanee Boiler Co., Kewanee, Ill.

Pumps, Centrifugal

Alberger Condenser Co., New York.
Morris Machine Works, Baldwinsville, N. Y.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Pumps, Electric

Dean Bros. Steam Pump Works, Indianapolis, Ind.
Du Bois Iron Works, Du Bois, Pa.
Goulds Mfg. Co., Seneca Falls, N. Y.
Northern Electrical Mfg. Co., Madison, Wis.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Pumps, Hydraulic

Goulds Mfg. Co., Seneca Falls, N. Y.

Pumps, Oil

Burt Mfg. Co., Akron, O.
Detroit Lubricator Co., Detroit, Mich.
Du Bois Iron Works, Du Bois, Pa.
Goulds Mfg. Co., Seneca Falls, N. Y.
Lunkenheimer Co., Cincinnati, O.
Manzel Bros. Co., Buffalo, N. Y.
Sherwood Mfg. Co., Buffalo, N. Y.
Sight Feed Oil Pump Co., Milwaukee, Wis.

Pumps, Power

Deming Co., Salem, Ohio.
Myers & Bro., F. E., Ashland, O.
Patterson & Co., Frank L., New York.
Stewart Heater Co., Buffalo, N. Y.
Whitlock Coil Pipe Co., Hartford, Conn.

Pumps, Steam

Buffalo Steam Pump Co., Buffalo, N. Y.
Dean Bros. Steam Pump Works, Indianapolis, Ind.
Du Bois Iron Works, Du Bois, Pa.
Gardner Governor and Separator Co., Quincy, Ill.
Mason Regulator Co., Boston, Mass.
Minneapolis Steel & Machry. Co., Minneapolis, Minn.
Murray Iron Works Co., Burlington, Iowa.
Prescott Steam Pump Co., F. M., Milwaukee, Wis.
Safety Equipment Mfg. Co., Chicago, Ill.
Warren Steam Pump Co., Warren, Mass.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Pumps, Triplex

Minneapolis Steel & Mchry. Co., Minneapolis, Minn.

Pumps, Turbine

Alberger Condenser Co., New York.

Pumps, Vacuum

Alberger Condenser Co., New York.
Prescott Steam Pump Co., F. M., Milwaukee, Wis.
Wheeler Mfg. Co., C. H., Philadelphia, Pa.

Rams, Steam

Penberthy Injector Co., Detroit, Mich.

Reducing Wheels

American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Trill Indicator Co., Corry, Pa.

Refractories

Harbison-Walker Refractories Co., Pittsburg, Pa.

Refrigerating Machinery

De La Vergne Machine Co., New York.
Vilter Mfg. Co., Milwaukee, Wis.
Vogt Machine Co., Henry, Louisville, Ky.
York Mfg. Co., York, Pa.

Regulators, Damper

Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Lagonda Mfg. Co., Springfield, O.
Mason Regulator Co., Boston, Mass.

Regulators, Damper—*Cont.*

Robertson & Sons, Jas. L., New York.
Strong, Carlisle & Hammond Co., Cleveland, O.

Regulators, Feed Water

American Boiler Economy Co., Philadelphia, Pa.
Berry Engineering Co., Chester, Pa.
Chaplin-Fulton Mfg. Co., Pittsburg, Pa.
Davis Regulator Co., G. M., Chicago, Ill.
Jerguson Mfg. Co., Boston, Mass.
Lagonda Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Mason Regulator Co., Boston, Mass.
Safety Equipment Mfg. Co., Chicago, Ill.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Philadelphia, Pa.

Regulators, Pressure

American Boiler Economy Co., Philadelphia, Pa.
American District Steam Co., Lockport, N. Y.
Davis Regulator Co., G. M., Chicago, Ill.
Lagonda Mfg. Co., Springfield, O.
Mason Regulator Co., Boston, Mass.
Ohio Brass Co., Mansfield, Ohio.
Strong, Carlisle & Hammond Co., Cleveland, O.

Regulators, Rheostat

Mason Regulator Co., Boston, Mass.

Repairs, Engine and Pump

Underwood & Co., H. B., Philadelphia, Pa.

Reseating Machines, Flue Cap

Lagonda Mfg. Co., Springfield, O.
Leavitt Machine Co., Orange, Mass.
Liberty Mfg. Co., Pittsburg, Pa.

Revolution Counters

American Steam Gauge & Valve Mfg. Co., Boston, Mass.

Rope Dressing

Cling Surface Co., Buffalo, N. Y.

Rope Transmission

American Mfg. Co., New York.
Dodge Mfg. Co., Mishawaka, Ind.
Plymouth Cordage Co., No. Plymouth, Mass.

Rubber Goods

Garlock Packing Co., Palmyra, N. Y.
Griscom-Spencer Co., New York.
Home Rubber Co., Trenton, N. J.
Mechanical Rubber Co., Cleveland, Ohio.
Mercer Rubber Co., Hamilton Square, N. J.
National India Rubber Co., Bristol, R. I.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.
Restein Co., Clement, Philadelphia, Pa.
Rhoads & Sons, J. E., Philadelphia, Pa.

Schools, Correspondence

International Correspond. Schools, Scranton, Pa.

Separators, Ammonia

Harrison Safety Boiler Works, Philadelphia, Pa.

Separators, Oil

Austin Separator Co., Detroit, Mich.
Baragwanath & Son, Wm., Chicago, Ill.
Direct Separator Co., Syracuse, N. Y.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hershey Foundry & Machine Co., Manheim, Pa.
Hoppes Mfg. Co., Springfield, O.
Hussey, McCann & Co., New York.
Liberty Mfg. Co., Pittsburg, Pa.
Loew Mfg. Co., Cleveland, O.
Marion Incline Filter & Heater Co., Marion, Ohio.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Ohio Blower Co., Cleveland, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Robertson & Sons, Jas. L., New York.
Webster & Co., Warren, Camden, N. J.
Wright Mfg. Co., Detroit, Mich.

Separators, Oil and Water

Harrison Safety Boiler Works, Philadelphia, Pa.
Keyes & Son, F. E., New York.

Separators, Steam

Austin Separator Co., Detroit, Mich.
Baragwanath & Son, Wm., Chicago, Ill.
d'Este & Co., Julian, Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Gardner Governor and Separator Co., Quincy, Ill.
Harrison Safety Boiler Works, Philadelphia, Pa.
Hershey Foundry & Machine Co., Manheim, Pa.
Hoppes Mfg. Co., Springfield, O.
Liberty Mfg. Co., Pittsburg, Pa.
Loew Mfg. Co., Cleveland, O.
Marion Incline Filter & Heater Co., Marion, Ohio.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Ohio Blower Co., Cleveland, O.
Patterson & Co., Frank L., New York.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Robertson & Sons, Jas. L., New York.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.
Sims Co., Erie, Pa.
Webster & Co., Warren, Camden, N. J.
Whitlock Coil Pipe Co., Hartford, Conn.
Wright Mfg. Co., Detroit, Mich.

Shafts, Counter

Myers & Bro., F. E., Ashland, O.

Sheaves

Minneapolis Steel & Mchy. Co., Minneapolis, Minn.

Skimmers, Boiler

Buckeye Boiler Skimmer Co., Toledo, Ohio.

Skylights

Burt Mfg. Co., Akron, O.

Smoke Preventers

Climax Smoke Preventer Co., Boston, Mass.

Spray Nozzles

Schutte & Koerting Co., Philadelphia, Pa.

Stacks, Steel

Bigelow Co., New Haven, Conn.
Keeler Co., E., Williamsport, Pa.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
Morrin Climax Boiler Co., Brooklyn, N. Y.

Steam Heating Supplies

Beggs & Co., James, New York.
Crosby Steam Gage & Valve Co., Boston, Mass.
Dunham Co., C. A., Marshalltown, Iowa.
Eastwood Wire Mfg. Co., Belleville, N. J.
Nason Mfg. Co., New York.
New York Belting & Packing Co., New York.
Ohio Brass Co., Mansfield, O.
Peerless Rubber Mfg. Co., New York.
Reliance Gauge Column Co., Cleveland, O.
Strong, Carlisle & Hammond Co., Cleveland, O.
Wright Mfg. Co., Detroit, Mich.

Steam Specialties

Crane Co., Chicago, Ill.
Ohio Brass Co., Mansfield, Ohio.

Stocks, Die

Toledo Pipe Threading Machine Co., Toledo, O.

Stokers, Mechanical

Detroit Stoker and Foundry Co., Detroit, Mich.
Green Engineering Co., Chicago, Ill.
McClave-Brooks Co., Scranton, Pa.
Murphy Iron Works, Detroit, Mich.
Westinghouse Mach. Co., Pittsburg, Pa.
Wilkinson Mfg. Co., Bridgeport, Pa.

Strainers

American Injector Co., Detroit, Mich.
Liberty Mfg. Co., Pittsburg, Pa.
Webster & Co., Warren, Camden, N. J.

You can have, free of charge, a booklet on boiler scale and its removal, if you will send us your name and address on a postal card.

This booklet was made here in our own laboratories by men who have spent a life time in this business. For that reason all the statements have been boiled down and nothing but hard facts left.

THIS BOOK FREE.

This is a book which will give you ideas about cleaning boilers, using the blow-off, about foaming, corrosion and boiler scale itself.

It is yours for the asking. Send us your name and address on a postal card. Ask for the book entitled "Boiler Scale: Its Formation and Removal" by Geo. W. Lord.

George W. Lord Co.,
2238-2250 North 9th St.,
Philadelphia, Penna.

Superheaters
Babcock & Wilcox Co., New York.
Parker Boiler Co., Philadelphia, Pa.
Power Specialty Co., New York.
Providence Engineering Works, Providence, R. I.

Switchboards
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Switches, Electric
General Electric Co., Schenectady, N. Y.
Ohio Brass Co., Mansfield, O.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Syphons
National Tube Co., Pittsburg, Pa.
Schutte & Koerting Co., Philadelphia, Pa.

Tanks
Bigelow Co., New Haven, Conn.
Griscom-Spencer Co., New York.
Minneapolis Steel & Mchy. Co., Minneapolis, Minn.
New Bedford Boiler & Mach. Co., New Bedford, Mass.

Taps and Dies
Toledo Pipe Threading Machine Co., Toledo, O.

Thermometers
Bristol Co., Waterbury, Conn.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Tools
Mound Tool & Scraper Co., St. Louis, Mo.
Trimont Mfg. Co., Roxbury, Mass.

Transformers and Converters
General Elec. Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Transmission
American Mfg. Co., New York.
American Pulley Co., Philadelphia, Pa.
Dodge Mfg. Co., Mishawaka, Ind.
Gandy Belting Co., Baltimore, Md.
Jeffrey Mfg. Co., Columbus, O.
Mesta Machine Co., Pittsburg, Pa.
Minneapolis Steel & Machinery Co., Minneapolis, Minn.
Plymouth Cordage Co., No. Plymouth, Mass.
Rhoads & Sons, J. E., Philadelphia, Pa.

Traps
American District Steam Co., Lockport, N. Y.
Anderson Co., V. D., Cleveland, O.
Central Station Steam Co., Detroit, Mich.
Davis Co., John, Chicago, Ill.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.
Direct Separator Co., Syracuse, N. Y.
Dunham Co., C. A., Marshalltown, Iowa.
Flinn, Richard J., W. Roxbury Station, Boston, Mass.
Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
Harrison Safety Boiler Works, Philadelphia, Pa.
McCrea & Co., James, Chicago, Ill.
Morehead Mfg. Co., Detroit, Mich.
Nason Mfg. Co., New York.
Ohio Blower Co., Cleveland, O.
Platt & Co., John, New York.
Reliance Gauge Column Co., Cleveland, O.
Safety Equipment Mfg. Co., Chicago, Ill.
Strong, Carlisle & Hammond Co., Cleveland, O.
Watson & McDaniel Co., Philadelphia, Pa.
Webster & Co., Warren, Camden, N. J.
Wright Mfg. Co., Detroit, Mich.

Tube Cleaners
See Cleaners (Boiler Tube).

Tube Cutters
Lagonda Mfg. Co., Detroit, Mich.

Tubing
National Tube Co., Pittsburg, Pa.

Tubing, Metallic
Pennsylvania Flexible Metallic Tubing Co., Philadelphia, Pa.

Turbines, Steam
De Laval Steam Turbine Co., Trenton, N. J.
General Elec. Co., Schenectady, N. Y.
Kerr Turbine Co., Wellsville, N. Y.
Westinghouse Machine Co., Pittsburg, Pa.
Wing Mfg. Co., L. J., New York.

Unions
Bard Union Co., Norwich, Conn.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Dart Mfg. Co., E. M., Providence, R. I.
Jefferson Union Co., Lexington, Mass.
National Tube Co., Pittsburg, Pa.
Ohio Brass Co., Mansfield, O.

Valves & Washers, Leather
Rhoads & Sons, J. E., Phila., Pa.
Schieren Co., Chas. A., New York.

Valve Discs
Allan & Son, A., New York.
Mechanical Rubber Co., Cleveland, O.

Valve Reseating Machine
Leavitt Machine Co., Orange, Mass.

Valve Seat Planing Machine
Underwood & Co., H. B., Philadelphia, Pa.

Valves
Crane Co., Chicago, Ill.
Liberty Mfg. Co., Pittsburg, Pa.
National Tube Co., Pittsburg, Pa.
New Bedford Boiler & Mach. Co., New Bedford, Mass.
Ohio Brass Co., Mansfield, O.

Valves, Ammonia
York Mfg. Co., York, Pa.

Valves, Angle
New Bedford Boiler & Mach. Co., New Bedford, Mass.

Valves, Automatic
Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
Lagonda Mfg. Co., Springfield, O.
Safety Equipment Mfg. Co., Chicago, Ill.
Webster & Co., Warren, Camden, N. J.

Valves, Back Pressure
Schutte & Koerting Co., Philadelphia, Pa.
Walch & Wyeth, Chicago, Ill.

Valves, Balance
Mason Regulator Co., Boston, Mass.

Valves, Blow-off
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Homestead Valve Mfg. Co., Pittsburg, Pa.
Huxley Valve Co., Buffalo, N. Y.
Liberty Mfg. Co., Pittsburg, Pa.
Ludlow Valve Mfg. Co., Troy, N. Y.
Lunkenheimer Co., Cincinnati, O.
Pittsburg Gage & Supply Co., Pittsburg, Pa.

Valves, Boiler Stop
Davis Regulator Co., G. M., Chicago, Ill.
Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
New Bedford Boiler & Mach. Co., New Bedford, Mass.

Valves, By-Pass
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Mason Regulator Co., Boston, Mass.

Valves, Check
Greene, Tweed & Co., New York.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Ludlow Valve Mfg. Co., Troy, N. Y.
Nelson Valve Co., Philadelphia, Pa.
Pittsburg Valve and Fittings Co., Pittsburg, Pa.
Walch & Wyeth, Chicago, Ill.

Valves, Cylinder Relief
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.

Valves, Electric
Nelson Valve Co., Philadelphia, Pa.

Valves, Electrically Operated Trip
Schutte & Koerting Co., Philadelphia, Pa.

Valves, Exhaust
Nelson Valve Co., Philadelphia, Pa.

Valves, Exhaust Relief
Alberger Condenser Co., New York.
Davis Co., John, Chicago, Ill.
Walch & Wyeth, Chicago, Ill.

Valves, Foot
New Bedford Boiler & Mach. Co., New Bedford, Mass.

Valves, Free Exhaust
Schutte & Koerting Co., Philadelphia, Pa.

Valves, Gas
Nelson Valve Co., Philadelphia, Pa.

Valves, Gate
Central Station Steam Co., Detroit, Mich.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Greene, Tweed & Co., New York.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Ludlow Valve Mfg. Co., Troy, N. Y.
Nelson Valve Co., Philadelphia, Pa.
Ohio Brass Co., Mansfield, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Pittsburgh Valve & Fittings Co., Pittsburg, Pa.
Pittsburgh Valve, Fdry. & Construction Co., Pittsburg, Pa.
Walch & Wyeth, Chicago, Ill.

Valves, Globe
Detroit Lubricator Co., Detroit, Mich.
Eastwood Wire Mfg. Co., Belleville, N. J.
Ludlow Valve Mfg. Co., Troy, N. Y.
Lunkenheimer Co., Cincinnati, O'
Nelson Valve Co., Philadelphia, Pa.
New Bedford Boiler & Mach. Co., New Bedford, Mass.
Ohio Brass Co., Mansfield, O.
Pittsburgh Valve & Fittings Co., Pittsburg, Pa.
Pittsburgh Valve, Fdry. and Construction Co., Pittsburg, Pa.
Powell Co., Wm., Cincinnati, O.

Valves, Hose Gate
Nelson Valve Co., Philadelphia, Pa.

Valves, Hydraulic
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Nelson Valve Co., Philadelphia, Pa.
Schutte & Koerting Co., Philadelphia, Pa.

Valves, Incinerator
Nelson Valve Co., Philadelphia, Pa.

Valves, Lever Gate
Nelson Valve Co., Philadelphia, Pa.

Valves, Lever and Throttle
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Mason Regulator Co., Boston, Mass.
Powell Co., Wm., Cincinnati, O.

Valves, Non-return
Golden-Anderson Valve Specialty Co., Pittsburg, Pa.
Walch & Wyeth, Chicago, Ill.

Valves, Pneumatic
Nelson Valve Co., Philadelphia, Pa.

Valves, Pop Safety
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Kunkle & Co., E. B., Fort Wayne, Ind.
Lunkenheimer Co., Cincinnati, O.
Star Brass Mfg. Co., Boston, Mass.

Valves, Pump
Garlock Packing Co., Palmyra, N. Y.
Johnson Co., Henry, Jersey City, N. J.
Mechanical Rubber Co., Cleveland, O.
New York Belting & Packing Co., New York.

Valves, Pump —*Continued.*
Peerless Rubber Mfg. Co., New York.
Quaker City Rubber Co., Philadelphia, Pa.

Valves, Railroad
Nelson Valve Co., Philadelphia, Pa.

Valves, Reducing
See Pressure Regulators.

Valves, Regrinding
Nelson Valve Co., Philadelphia, Pa.

Valves, Regulating
Ohio Brass Co., Mansfield, Ohio.

Valves, Safety
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Kunkle & Co., E. B., Fort Wayne, Ind.
Pittsburgh Valve, Fdry. & Construction Co., Pittsburg, Pa.
Walch & Wyeth, Chicago, Ill.

Valves, Safety Gate
Walch & Wyeth, Chicago, Ill.

Valves, Steam
Nelson Valve Co., Philadelphia, Pa.

Valves, Stop Check
Schutte & Koerting Co., Philadelphia, Pa.

Valves, Superheated Steam
Nelson Valve Co., Philadelphia, Pa.

Valves, Swing Gate
Walch & Wyeth, Chicago, Ill.

Valves, Tank
Nelson Valve Co., Philadelphia, Pa.

Valves, Water
Nelson Valve Co., Philadelphia, Pa.

Valves, Water Relief
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Davis Regulator Co., G. M., Chicago, Ill.
d'Este Co., Julian, Boston, Mass.

Ventilators
Burt Mfg. Co., Akron, O.
Ohio Blower Co., Cleveland, O.
Wing Mfg. Co., L. J., New York

Vulcanizers
Bigelow Co., New Haven, Conn.

Water Columns
Davis Co., John, Chicago, Ill.
Jerguson Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Pittsburgh Gage & Supply Co., Pittsburg, Pa.
Reliance Gauge Column Co., Cleveland, O.
Robertson & Sons, Jas. L., New York.
Safety Equipment Mfg. Co., Chicago, Ill.
Wright Mfg. Co., Detroit, Mich.

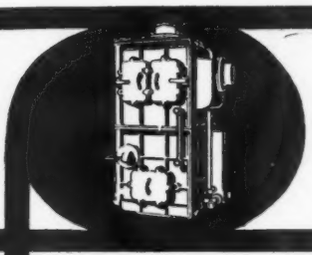
Water Purifiers, Feed
Harrison Safety Boiler Works, Philadelphia, Pa.
Keyes & Son, F. E., New York.

Water Softening Apparatus
Bird-Archer Co., New York.
Dodge Mfg. Co., Mishawaka, Ind.
Harrison Safety Boiler Works, Philadelphia, Pa.
Marion Incline Filter & Heater Co., Marion, O.
Scaife & Sons Co., Wm. B., Pittsburg, Pa.

Whistles
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, O.
Schaeffer & Budenberg Mfg. Co., Foxboro, Mass.

Wrenches
Trimont Mfg. Co., Roxbury, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

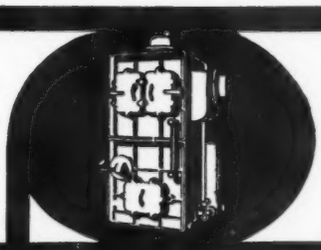
Wrenches, Pipe
Trimont Mfg. Co., Roxbury, Mass.
Williams & Co., J. H., Brooklyn, N. Y.



COCHRANE NOTES

ON STEAM PLANT ECONOMY

"Never too late to install a Cochrane Steam Separator until the engine has been wrecked by water."

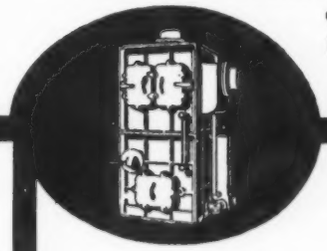


"Neglect to put in a Cochrane Separator goeth before destruction, and carelessness about the kind of feed water heater before loss of money."

"Where your exhaust steam is, there are your profits also."

"Two heads are better than one in planning a steam plant. Submit your plans to our Engineering Department for suggestions."

"The proof of the purifying action of the Cochrane Heater is in the cleaning thereof."



"Tell us the temperature of your boiler feedwater and we will tell you how much money a Cochrane Heater will save for you."

"Scaly boilers keep a dear school, but some people will learn in none other. Better put in our Hot Process System of Water Softening in the first place."

"When boiler scale can be cured, why should it be endured? We guarantee that hard scale will not form in boilers fed from our Hot Process System of Water Purification."

"It is poor economy to save at the throttle and waste in the exhaust. Utilize the exhaust, previously purified of oil by a Cochrane Separator; for heating or drying or for producing hot water in a Cochrane Heater."

"Happy is the man that findeth wisdom and the man that buyeth a Cochrane Heater. Length of days is given unto the boiler, and unto the owner riches and honor. Then shall he walk in his way safely and his boilers shall not blow up."

A willing engineer does not wait until he is asked about Cochrane Heaters; he sends for our Treatise on "The Profitable Utilization of Exhaust Steam."

HARRISON SAFETY BOILER WORKS

SEVENTEENTH AND CLEARFIELD STS., PHILADELPHIA, PA.

TRIMO PIPE CUTTER

(TRADE MARK)

Combination 1 and 3 Wheel.

NOT THE CHEAPEST,
BUT THE BEST.

Only a trial needed to demonstrate its superior qualities. Drop forged steel frame. Rolls keep cutter straight and remove burrs from pipe. All parts interchangeable and guaranteed. Send for our Catalogue No. 21.

TRIMONT MANUFACTURING COMPANY, 55-71 Amory Street, Roxbury, Mass.

BARGAINS IN NEW AND SECOND-HAND ENGINE-GENERATOR SETS

Special—One NEW 500 K.W. Steam Turbine-Alternator Set, 2300 Volt, 60 Cycles, 3 Phase
One NEW 250 K.W. Steam Turbine-Alternator Set, 2300 Volt, 60 Cycles, 2 Phase

M. B. LUDLOW, 710 Morris Bldg., New Orleans, La.

A Fifty-Thousand-Engineers' Paper

50,000 separate individuals read the two editions of *Power and The Engineer.* The every-issue-advertiser reaches every reader. Some papers have circulations like many women have hair—less in private than in public. *Power and The Engineer's* subscription lists are wide open to present and prospective advertisers. A "Circulation Chart" sent upon request.

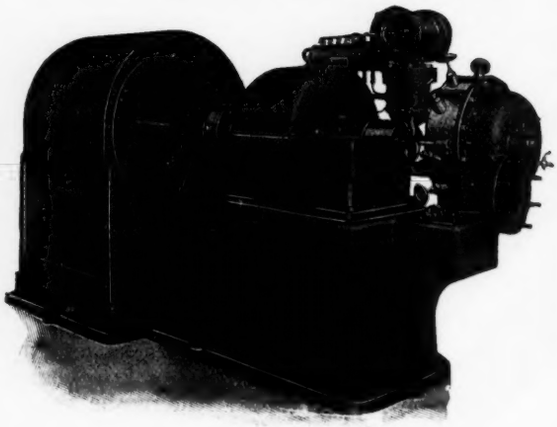
505 Pearl Street, New York

"SIROCCO"

TRADE MARK

BLOWERS

BUILT ON THE TURBINE PRINCIPLE
MOST EFFICIENT FOR ALL DUTIES

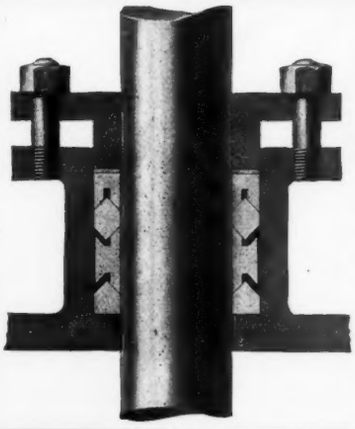


STEAM TURBINE UNIT

20" Double Inlet Sirocco Blower, Direct connected to a steam turbine for forced draft. Capacity of 28,000 cu. ft. against a pressure of 5½" water gauge. EFFICIENCY 65%.

SIROCCO ENGINEERING CO.

138-140 Cedar St., New York. Works: Troy, N. Y.



LAW

IMPROVED

Metallic Packing

adapted for *high* and *low* pressures with saturated and superheated steam—air, gas, water, oil, ammonia, etc.

HOUCHIN-AIKEN CO.,
Sole Manufacturers,
37-47 Fifty-third Street,
Brooklyn, New York.

BOOKS

We are publishing the best books for engineers—we handle all books of all publishers. When you get up against a knotty question, write us and if there is a good book to help you out, we can supply it.

HILL PUBLISHING COMPANY,
505 PEARL ST., NEW YORK.

STEAM-TRAP TALK

AND A FEW REASONS WHY OUR TRAPS PLEASE . . .

BECAUSE

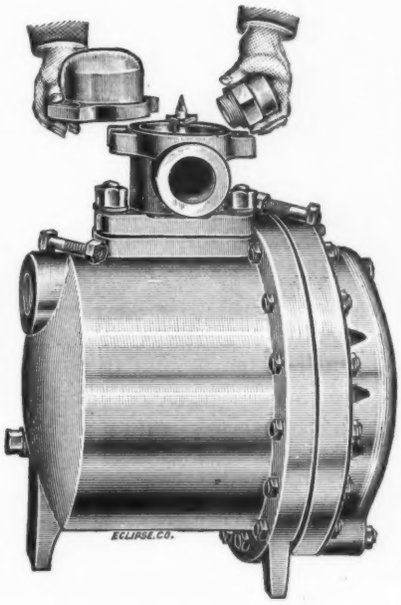
it is so easy to inspect—the wearing parts, the valve and seat—see cut.

BECAUSE

the trap mechanism is operated by a cast iron bucket—see sectional cut. No ball floats to collapse or water log.

BECAUSE

they are safe, every trap tested at 600 pounds hydrostatic.



BECAUSE

there are no internal parts that get out of order. No levers or toggles or inside valves.

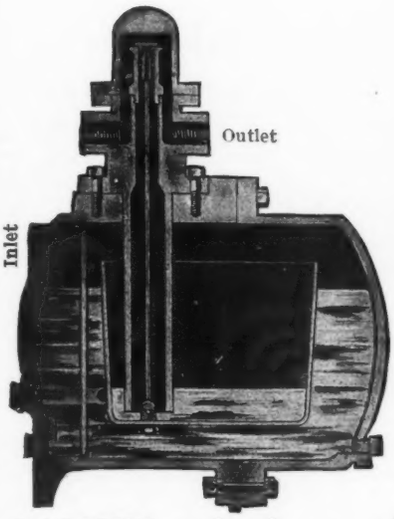
BECAUSE

no adjustments ever have to be made.

BECAUSE

the bucket is connected by a leverage to the valve, thus giving great capacity to the trap.

EASY



BECAUSE

the action is intermittent, this reduces wire drawing to a minimum and acts as a pump on any water lying in pockets, etc.

BECAUSE

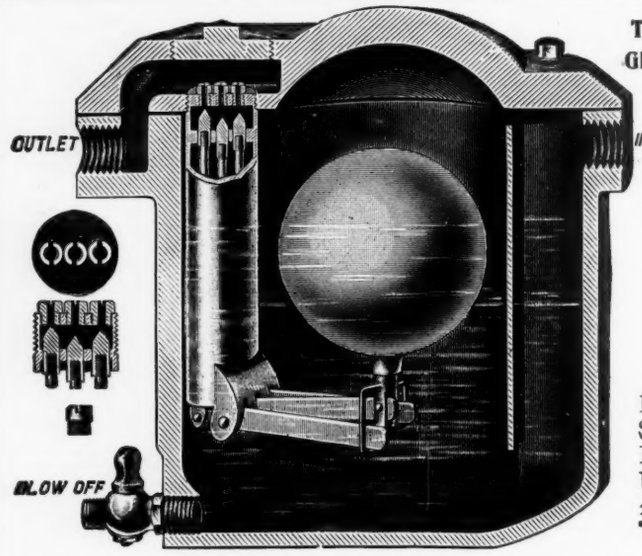
every trap is guaranteed to give satisfaction.

We have a 44-page Catatog containing other BECAUSES and other specialties—PRESSURE REGULATORS, PUMP GOVERNORS, BOILER FEED WATER REGULATORS. OUR LATEST CATALOG A-24. Shall we send it ?

The Strong, Carlisle & Hammond Co.,

342 Frankfort Ave., Cleveland, Ohio.

261 CENTRE ST., NEW YORK. 88 BROAD ST., BOSTON. 54 NO. 6TH ST., PHILADELPHIA.



The
Wright
"Emergency"
High Pressure
Continuous Flow
Steam Trap

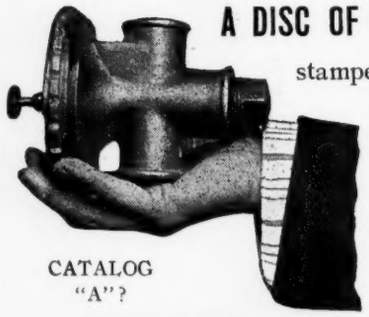
For Steam Pressure Up to 250 pounds.

Drains Automatically and Continually the Accumulating Condensation from Steam Lines and Connections. Discharges the water perfectly regardless of Small Flows or Floods and without the waste of steam in course of operation. Guarantees the economy and efficiency of DRY STEAM.

We ship subject to 30 days' trial and return to us at our expense if results are not satisfactory. Send for catalog.

WRIGHT MANUFACTURING CO.,

DETROIT, MICH. **27 Woodbridge Street.**



A DISC OF SPECIAL BRONZE

stamped by special machinery is used to hold a volatile fluid which expands and contracts its corrugated walls, thus opening and closing the valve of *Dunham's Steam Trap.*

CATALOG "A"?

Have one on trial?

C. A. DUNHAM COMPANY, Marshalltown, Iowa, U. S. A.

Chicago. Cleveland. Toronto. Philadelphia.

Nason Steam Traps

"SIDELUG" TRAP
(Patented)

THE STANDARD FOR SIXTY YEARS!

Adapted for all conditions requiring the removal of condensation without loss of steam.

SPECIFY:

"CLASS B"—For pressures under 20 lbs.
"CLASS C"—For pressures between 20 and 70 lbs.
"SIDELUG"—For pressures higher than 40 to 150 lbs.

Send for Catalog.

NASON MFG. CO., NEW YORK.

A Fat Pay Envelope

goes to the man who knows, and this recording meter furnishes the requisite information. A continuous, permanent record, which may be read at any minute or be filed away for future reference.

WRITE.

G. C. ST. JOHN
140 Cedar St., New York.

The St. John Indicating and Recording Steam Meter

WE DO THIS

TO DRAW ATTENTION TO THE **GEIPEL STEAM TRAP.**

Made in Seven Sizes for All Classes of Service.
Descriptive Circulars on Request.

JOHN PLATT & COMPANY
97 Cedar Street **NEW YORK**

The BLACKBURN SMITH
Feed Water Filter and Grease Extractor

removes oil and other suspended impurities from feed water by means of *double* filtration through layers of terry cloth. No other filter is so easy to clean and so thorough in action.
Write for free book on *"Feed Water Filtration."*

JAMES BEGGS & CO., 106 Liberty St., New York

Freedom From Grease

is an advantage that can be counted in dollars and cents.
The Peerless Grease Extractor eliminates the danger and expense due to grease-bearing steam. If it doesn't satisfy don't pay us. Booklet free.

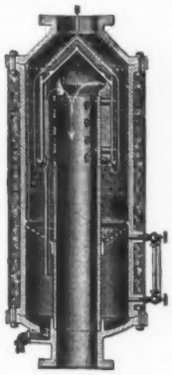
HUSSEY, McCANN & CO.,
87 Warren Street. NEW YORK

IF IT'S A BAUM SEPARATOR

you can rest assured that the purification of your live steam is being accomplished with *economy* and *certainty*. All water, oil, grit, etc, will be removed. Take us up on our 30 day trial offer.

Write for catalog.

THE HERSHEY
MACHINE & FOUNDRY CO.,
MANHEIM, PENNSYLVANIA.
W.G.Ruggles Co., 84 High St., Boston, Mass.
R. D. Bliss, 40 Dearborn St., Chicago, Ill.



Delivers Steam 99.8% Dry

Extracts 99% of the Oil

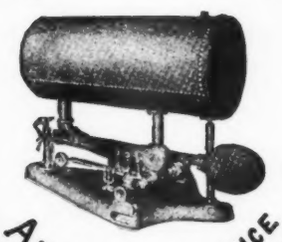
Sweets Separator

has ample separating surface and ample storage space for condensation so that when a lot of water or oil is coming it gets it all and keeps all it gets.

ASK FOR A CATALOG

Direct Separator Company
712 Geddes St., Syracuse, N. Y.

MOREHEAD



ALWAYS IN SERVICE

Eight Years' Continuous Use

and still working to perfection This No. 2 **Morehead Vacuum Trap** is repaying its cost repeatedly at Scott's Mill, Detroit, Michigan.

CATALOG ?

Morehead Manufacturing Co.,
1051 Grand River Ave., DETROIT, MICH.

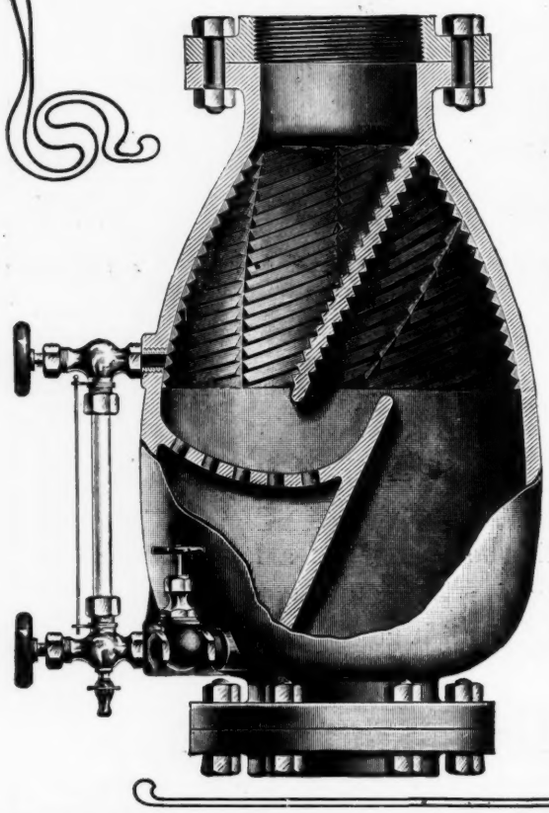
YOU CAN'T IMPROVE
On the "ANDERSON"
IMPROVED STEAM TRAP

It is always locked with at least three inches of water. You can get at the valve and seat without breaking a pipe connection. It works against any back pressure 5 pounds less than the steam pressure at the trap. It pays its cost in dry steam alone

Write for our "Trap Book."

THE V. D. ANDERSON COMPANY
1935 W. 96th St., Cleveland, Ohio.

Send for Illustrated Catalog.



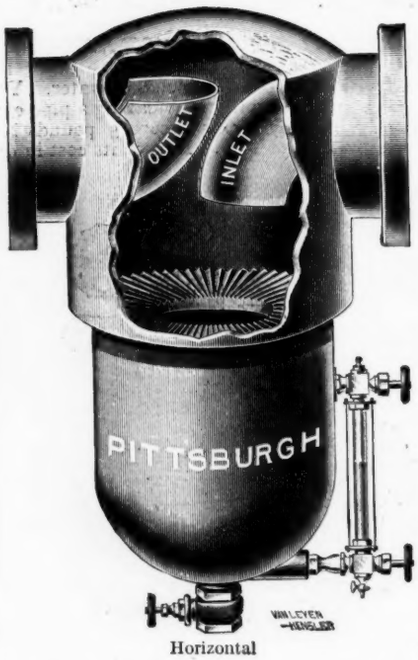
The Austin Figure "A" Vertical

Steam Separator

THIS Separator is adapted to every day conditions. It is not expensive. Its use guarantees the elimination of all moisture from the live steam current. It means that you will operate your engine with DRY STEAM. DRY STEAM INSURES THE HIGHEST EFFICIENCY AT THE LEAST POSSIBLE CONSUMPTION OF FUEL AND LUBRICANT. DRY STEAM INSURES NO CYLINDER EXPLOSIONS.
You can try this Separator 30 days and return it at our expense if results are not satisfactory.

AUSTIN SEPARATOR CO.
Detroit, Mich. **57 Woodbridge St.**

"Pittsburgh" Steam Separators



Horizontal

For Live or Exhaust Steam

Utterly Simple **Perfectly Effective**

Highest Efficiency—
Proved by Laboratory Tests.

No Baffle Plates—
To Cause Spattering Back.

No Contracted Areas—
To Retard Freedom of Flow.

No Small Passages—
To Foul and Clog.

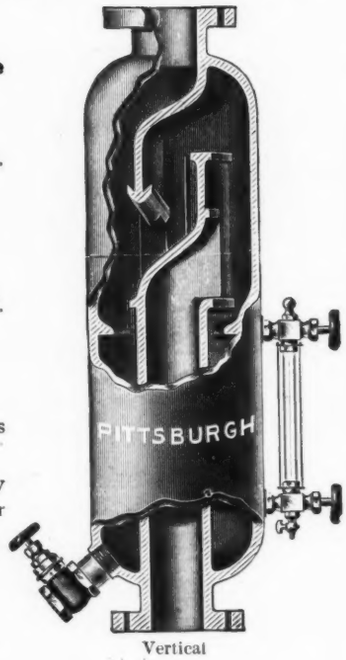
Perfect separation secured by sudden changes in direction of steam flow.

Separated water and oil drained directly away from steam current and into protected receiver space.

Horizontal and Vertical Types

Plain and Receiver Styles

Made in all sizes—Shipped on Guarantee Trial.



Vertical

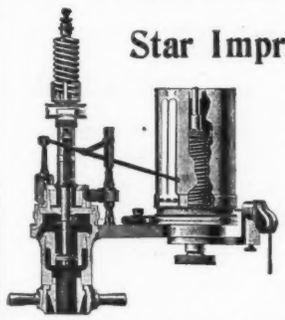
Pittsburgh Gage & Supply Co., Pittsburgh, Pa.

A PERFECT INDICATOR

IS THE

Star Improved Outside Spring

Class B Style.



Suitable for.....
High Pressures,
High Speeds,
Superheated Steam,
and all uses where absolute accuracy is required.

A QUALITY INSTRUMENT.

Send for Circular.

Manufactured Exclusively By

Star Brass Mfg. Co., 108-114 E. Dedham Street, **Boston, Mass.**

To Become Expert

as an engineer one must use an indicator.

GET ONE ON TRIAL

The Trill Triumph Indicator

costs $50 less, is a more durable, less troublesome and more accurate instrument than the higher priced makes.

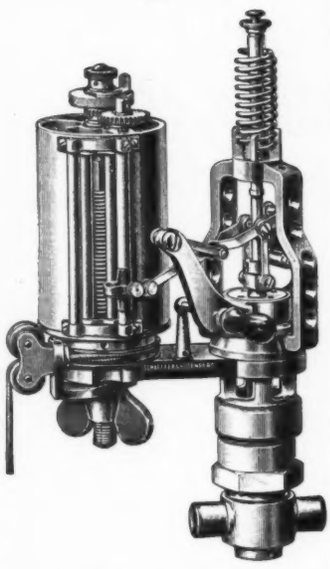
ASK FOR CATALOG.

TRILL INDICATOR CO., Eagle St., CORRY, PA.

The Thompson

Improved Continuous Card Indicator

The Most Modern, Useful and Practical Indicator on the Market.



This indicator shows not only the condition at a specific moment, but for a time sufficiently long to determine the true condition by the average showing. For engines in traction power stations and rolling mills, or wherever the load constantly varies, the continuous card diagram is of utmost value, and you will appreciate it when you know that from 50 to 100 indications can be taken without removal of the paper. Write for new catalog.

The Schaeffer & Budenburg Mfg. Co.,
Foxboro, Mass.
23 Dey St., New York. 15 W. Lake St., Chicago.

Easy to Buy and Hard to do Without

The Robertson - Thompson Indicator

together with the Victor Reducing Wheel is indispensable to the engineer who wants to know exactly what his engine is doing at all times. It makes highest economy easy to obtain.

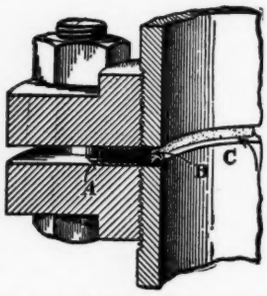
The price of the Robertson-Thompson is ⅓ less than others and we offer it to engineers on easy terms of payment if desired.

Principle, design and construction are absolutely correct.

Write For Catalog And Prices

Jas. L. Robertson & Son
46 Warren Street, New York

The Self-Sealing Gasket



The pressure enters the joint at "C," exerts its energy upon the filling "B" forcing "B" into and expanding the U-shaped metal ring "A."

Every gasket guaranteed to give satisfaction or money refunded. Send for descriptive circular and price list.

E. A. WILCOX MFG. CO., 260 E. 63rd St., Chicago, Ill.

"SAFETY" PLASTIC METALLIC PACKING

For Steam, Water, Air, Gas, Hydraulic Machines, Valves, Etc.

Guaranteed to stand Steam Temperature up to 550° F. and Hydraulic Pressure to 5000 lbs. per square inch.

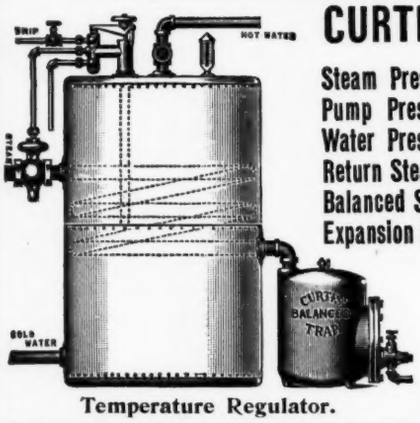
Highest Award World's Fair, St. Louis.

Send for **FREE SAMPLE** and particulars.

MANUFACTURED BY

STEEL MILL PACKING CO., Detroit, Mich., U.S.A.

CURTIS ENGINEERING SPECIALTIES



Temperature Regulator.

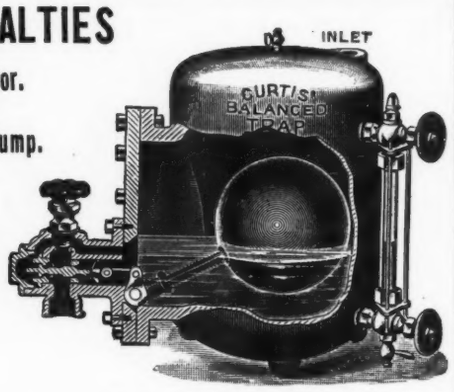
Steam Pressure Regulator.	Temperature Regulator.
Pump Pressure Regulator.	Damper Regulator.
Water Pressure Regulator.	Tank Governor and Pump.
Return Steam Trap.	Cellar Drainer.
Balanced Steam Trap.	Ballcock.
Expansion Steam Trap.	Separator.

Send for catalog.

MANUFACTURED BY

Julian d'Este Company,

24 Canal St., Boston, Mass.



Balanced Steam Trap.

For Highest Pressures—Steam, Oil, Compressed Air, Gases, Ammonia, Etc.—PENNSYLVANIA FLEXIBLE METALLIC TUBING

It will not leak; there is no rubber to blow out.

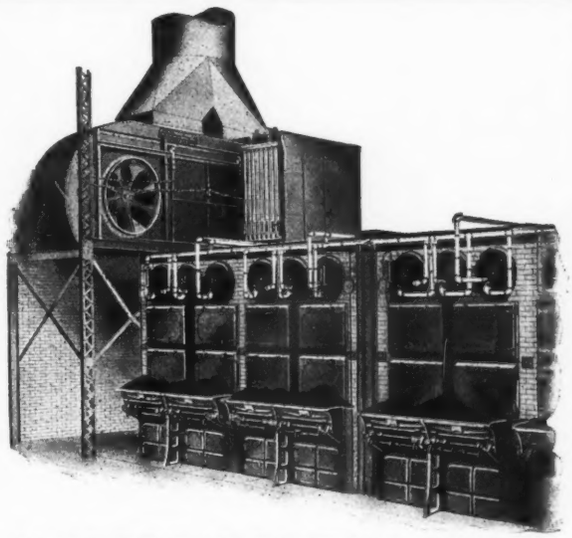
Note the edges. They interlock and completely enclose a thread of **asbestos** packing, which keeps the tubing tight and protects it from both internal and external wear. Made from Copper or Galvanized Steel Tape in one continuous length, rolled in spiral form. All sizes from $\frac{1}{8}$" to 12". *More flexible than rubber hose.*

Write for Circular.

PENNSYLVANIA FLEXIBLE METALLIC TUBING CO.,

S. H. COLLOM. **1305 Arch Street, Philadelphia, Pa.** H. A. ANSELL.

NEW YORK, 86 Warren Street. BOSTON, 71 High Street. CHICAGO, 255 LaSalle Street.



Induced Draft Plant of the United Electric Co. of New Jersey, Hoboken, N. J.

THE Buffalo Mechanical Draft System is the essential factor of advanced boiler practice. Is easily installed, flexible, positive and instantaneous. Makes feasible an increase of capacity without enlarging the boiler plant.

Ask for Booklet Mid.

THE BUFFALO FORGE CO.

Engineers and Manufacturers.

BUFFALO. NEW YORK. CHICAGO.

Canadian Buffalo Forge Co., Ltd. Montreal.

High Speed Engines. Fan System of Heating and Ventilating. Steel Plate Fans. Steel Pressure Blowers. ID-1.

Jeffrey Coal Handling Machinery

Installed for Speckel's Sugar Refinery

Capacity for handling 120 tons of coal hourly.

Bulletins B and C—free with catalog on elevating, conveying, screening, crushing, mining and drilling machinery.

The Jeffrey Mfg. Company

Columbus, Ohio, U. S. A.

New York Pittsburg Knoxville Chicago St Louis Charlestown, W. Va Boston Denver Montreal, Canada

ENGINE AND BOILER BARGAINS

ENGINES

20 x 42 Allis, Corliss	16 x 32 Buckeye, Automatic
18 x 42 Hamilton Corliss	14 x 24 Atlas, Automatic
18 x 36 Wright, Corliss	13½ x 15 Taylor, Automatic
14 x 24 Wright, Corliss	12 x 18 Brownell, Automatic
12 x 24 Wetherill, Corliss	12 x 14 Green, Automatic
10 x 30 Hamilton, Corliss	12 x 12 N. Y. Safety, Automatic

Also large assortment of Automatic and Throttling Engines of other sizes.

BOILERS

84 x 18, 78 x 16, 72 x 18 High Pressure, 72 x 16, 66 x 16 and smaller sizes of Horizontal Tubular Boilers, also Vertical and Fire Box Boilers from 5 to 60 H. P.

Heaters, Pumps, Tanks, Saw Mills, Iron Working Tools, etc., etc. Write for bargain list.

We are the sole manufacturers of the celebrated "Leader" Injectors and Jet Pumps.

THE RANDLE MACHINERY CO.

1768 Powers St., CINCINNATI, OHIO.

Compulsory Combustibility

is obtained by Wing's Turbine Fan System of Mechanical Draft.

By keeping the furnace temperature even and insuring perfect combustion (even of the cheapest fuels) the Wing System brings a wonderful economy to the power plant. The fire gets the exactly right amount of heated air in steady, even pressure and clinkers are reduced to a minimum. The price is moderate, it is easy to install and requires little attention. *Ask for the Catalog.*

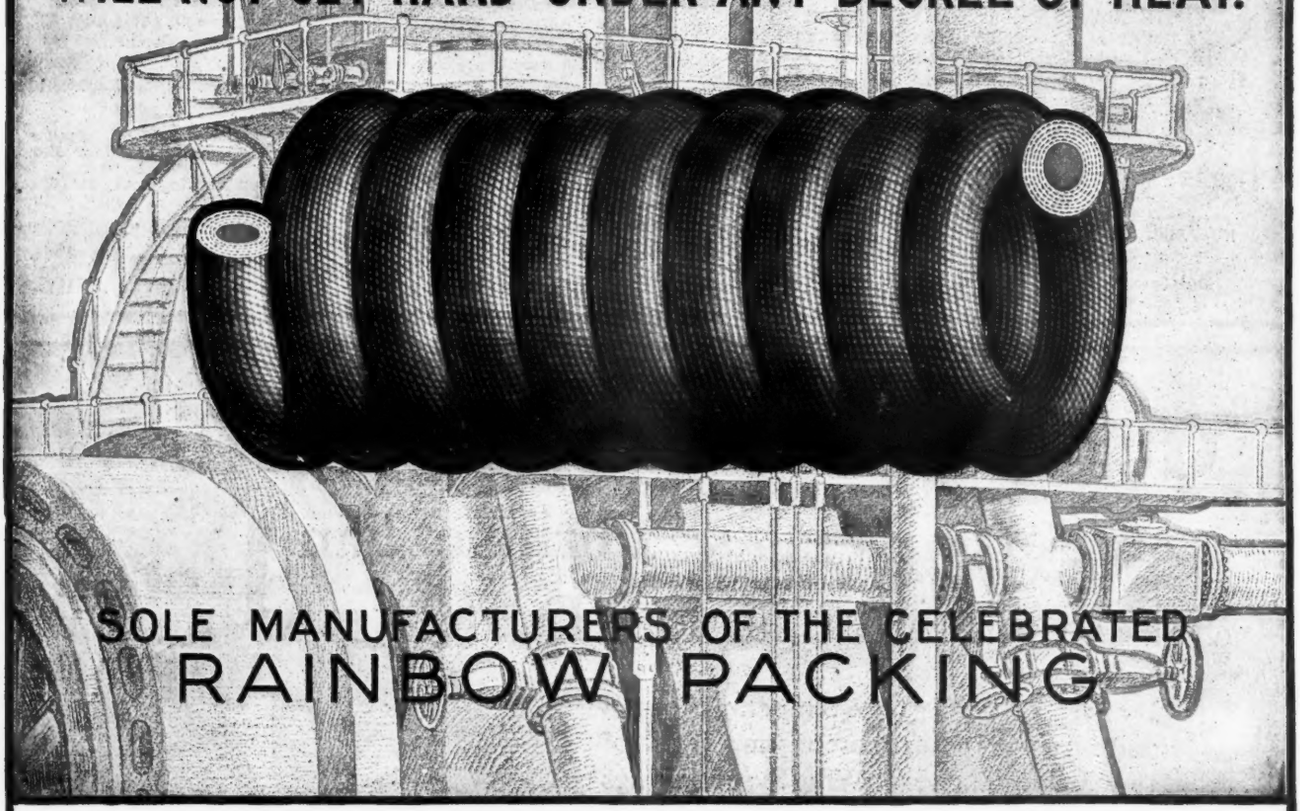
L. J. WING MFG. CO., 90 West St., Cor. Cedar, New York.

Mfgrs. Wing's Disc Fans, Blowers and Exhaust Fans

Designers and Builders of Heating and Ventilating Systems.

PEERLESS SPIRAL PISTON AND VALVE ROD PACKING

IS THE MOST SATISFACTORY PACKING IN THE WORLD.
IT WILL RUN FROM 12 TO 16 MONTHS WITHOUT REPACKING.
WILL HOLD 400 POUNDS OF STEAM.
IT WILL PACK TIGHTLY ANY ROD HOWEVER BADLY SCORED AND CORRODED.
WILL NOT GET HARD UNDER ANY DEGREE OF HEAT.



SOLE MANUFACTURERS OF THE CELEBRATED
RAINBOW PACKING

PATENTED MANUFACTURED EXCLUSIVELY BY

THE PEERLESS RUBBER MANUFACTURING COMPANY

16 WARREN ST., NEW YORK

DETROIT, MICH.—16-24 WOODWARD AVE.
CHICAGO, ILL.—202-210 SO. WATER ST.
PITTSBURG, PA.—425-427 FIRST AVE.
SAN FRANCISCO, CAL. 131 153 KANSAS ST.
NEW ORLEANS, LA.—COR. COMMON & TCHOUPITOULAS STS.
ATLANTA GA.—7-9 SOUTH BROAD ST.
KANSAS CITY, MO.—1221-1223 UNION AVE.
SEATTLE, WASH.—RAILROADWAY & OCCIDENTAL AVE.
LOUISEVILLE, KY—111-121 W. MAIN ST.
INDIANAPOLIS, IND—16-18 SQ. CAPITOL AVE
OMAHA, NEB.—1218 FARNAM ST.
DENVER, COL.—1723-1731 BLAKE ST.
RICHMOND, VA.—COR. NINTH & CAREY STS.
WACO, TEXAS—709-711 AUSTIN AVE.
BOSTON, MASS.—110 FEDERAL ST.
BUFFALO, 379-383 WASHINGTON ST.
MILWAUKEE, WIS. 96-100 SECOND ST.
SYRACUSE, N.Y.—212-214 SO. CLINTON ST.
LOS ANGELES, CAL—115 SO. LOS ANGELES ST.
PORTLAND, ORE.—14-16 FIRST ST.
BALTIMORE, MD.—37 HOPKINS PLACE.

FOREIGN DEPOTS

LONDON E.C., ENGLAND.—58 HOLBORN VIADUCT
PARIS FRANCE.—76 AVE DE LA REPUBLIQUE.
SYDNEY, AUSTRALIA.—270 GEORGE ST.
JOHANNESBURG, SOUTH AFRICA.—2427 MERCANTILE BL'D'G
COPENHAGEN, DEN.—FREDERIKSHOLMS KANAL 6.
VANCOUVER, B.C.—CARRAL & ALEXANDER STS.

N. B. O.

HOME RUBBER CO. TRENTON, N. J. STEAM NEVER BURN BLOW OUT. PACKING. CHICAGO TRADE MARK NEW YORK

The Original Black Sheet Packing.

O. I. M.
on its merit

High Pressure
Use where pressure is above 100 lbs.

N. B. O. Black Sheet is the most thoroughly reliable packing of its kind ever made.

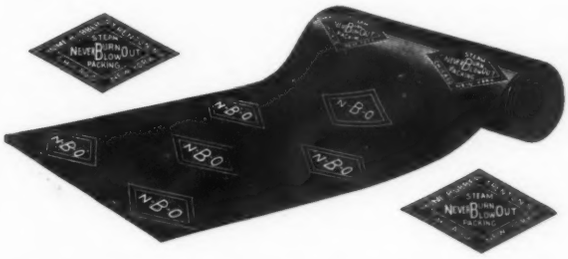
Our O. I. M. is made with two diagonally cut wedges, so put together that they will slip on each other and adopt themselves to any unevenness in a worn or scored rod.

None but the finest materials are used and perfect satisfaction guaranteed. Give it a test in your plant.

O. I. M.
on its merit

Low Pressure
Use where pressure does not exceed 100 lbs.

Ask Your Dealer For It



Or Write To Us Direct

Look for the N. B. O. Trade Mark.

Home Rubber Company

Woolverton Avenue, Trenton, N. J.

New York
80 and 82 Reade St.

Chicago
54-60 S. Canal St.

London—Balfour House
Finsbury Pavement.

COBB'S PISTON AND VALVE ROD PACKING

IS AN ENLIGHTENMENT TO THE ENGINEERING WORLD

BY USING
COBB'S PACKING,
ENGINEERS ENJOY
FREEDOM FROM WORRY
OWING TO THE SUPERIOR
CONSTRUCTION OF SAME
AND THE EXCELLENT QUALITY
OF THE MATERIALS EMPLOYED.

MANUFACTURED EXCLUSIVELY BY THE

NEW YORK BELTING AND PACKING CO LTD.

91-93 CHAMBERS STREET,
NEW YORK.

BRANCH STORES

CHICAGO, 150 LAKE ST. ST. LOUIS, 218-220 CHESTNUT ST.
PHILADELPHIA, 118-120 N. 8 TH ST. BOSTON, 232 SUMMER ST.
SAN FRANCISCO, (OAKLAND) EAST 11 TH ST. & 3RD AVE.
INDIANAPOLIS, 229 S. MERIDIAN ST. BALTIMORE, 114 W. BALTIMORE ST.
BUFFALO, 600 PRUDENTIAL BUILDING
PITTSBURGH, 913-915 LIBERTY AVE.
SPOKANE, WASH. 163 S. LINCOLN ST.
LONDON, E.C., ENGLAND, 58 HOLBORN VIADUCT

BELMONT
"1903" EXPANSION PACKING
For Steam and Ammonia

Pat. Feb. 24, 1903.

See the sliding wedge ?

When you place a ring in the stuffing box pull the ends of one wedge ahead of the casing ends, and push the other one back, then when the ring is closed and ready for service the joint is divided into three breaks, occurring at different points on the circumference. This feature enables one ring of **Belmont 1903 Expansion Packing** to stop steam as effectively as three rings of ordinary packing, and makes it especially valuable for shallow stuffing boxes. Material throughout is the best obtainable, and **Belmont 1903 Expansion Packing** (fully described in booklet A) is guaranteed for any service with steam or ammonia up to 125 lbs. pressure. Above this pressure our "high pressure" packing (write for booklet B) is to be preferred. *General Catalog on Request.*

FREE!

Send for a sample ring and be convinced.

CLEMENT RESTEIN CO.,
Philadelphia, Pa.

Gentlemen:—
Send me a sample ring of Belmont 1903 Expansion Packing

Name.....
Address.....
Firm Name.....
Number of Engines.....
Number of Pumps.....
Number of Boilers.....
High or Low Pressure.....
Packing now in use.....

Power, 7-7-08.

CLEMENT RESTEIN COMPANY

133 North Second St. PHILADELPHIA, PA.

OUR line of high quality packings includes, in addition to EUREKA GUM CORE, Eureka Cut Ring, High Pressure, Water Proof and Red Sheet. Ask your dealer for Genuine Eureka.

THIS LABEL ON PACKING "EUREKA" TRADE MARK. IS A GUARANTEE OF EXCELLENCE.

Eureka Cut Ring
AND IN SPIRAL FORM

though it costs much less, is guaranteed equal to any ring packing on the market.

Eureka High Pressure
IN COILS AND RINGS

is as nearly indestructible as can be made. High pressure and heat do not affect it.

Eureka Water Proof
IN COILS AND RINGS

A superior hydraulic packing that is impervious to cold water and extremely durable.

Eureka Red Sheet

specially intended for steam, gas and ammonia. Makes a tight joint under all conditions.

Our Prices and Delivery will interest you. Write for them.

Eureka Packing Company,

JAS. L. ROBERTSON, President,

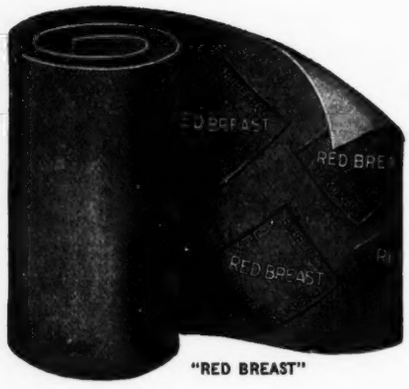
46 WARREN STREET, NEW YORK.

TRADE MARK
N.I.R.
RED SHEET PACKING

Unsurpassed for Durability.
Unaffected by extreme temperatures.
Impervious to action of gases, liquids and ammonia. Made of best grade rubber compound and finest quality asbestos fibre.
Guaranteed to withstand the highest steam pressure.

NATIONAL INDIA RUBBER CO.,
Factory: BRISTOL, R. I.
BRANCHES: 42 Broadway, New York. 84 Lake St., Chicago. 101 Milk St., Boston.
37 Hopkins Pl., Baltimore. 379 Washington St., Buffalo.

Red Breast Packing



"RED BREAST"

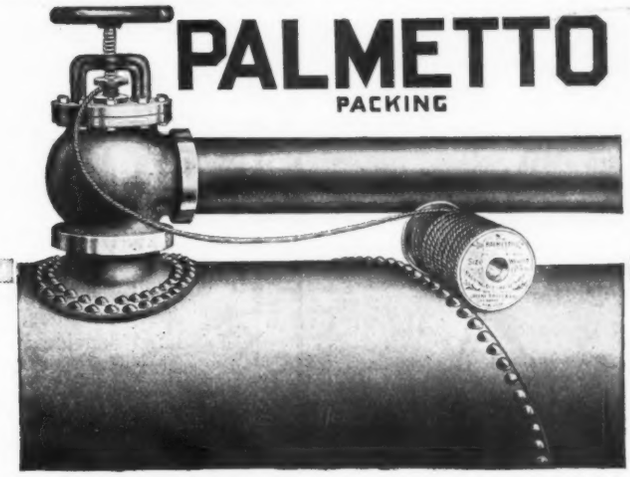
A Standard Red Sheet Packing—Will not crack or harden under any degree of heat; absolutely impervious to the influence of alkalies, oils and ammonia; positively won't contract or expand; and will withstand the highest pressure.

Write For Free Sample

This packing is better than others—far better—and, better still, is lower priced. We will gladly send samples **Free** upon request.

Mercer Rubber Company,
Hamilton Square, New Jersey.
BRANCH OFFICES—Philadelphia, New York, Pittsburg, Denver, 610 Exchange Building, and Chicago, 40 Dearborn St.

PALMETTO
PACKING



If you don't enjoy repacking the Header Valve you should be careful to use a packing that contains only mineral substance and constructed in such a way as to insure its remaining soft and pliable, for in this valve you have extreme conditions, as far as packing is concerned—the initial boiler pressure and extreme temperature, which make it impossible for any ordinary packing to last.

PALMETTO
PACKING

is not an ordinary packing, and is especially designed to meet the most extreme conditions of pressure and temperature.

FREE working samples will prove this to you.

SEND FOR SAME.

GREENE, TWEED & CO.,
SOLE MANUFACTURERS.
109 DUANE ST., NEW YORK.

Which was the cheaper?

April, 10 — Used 14½ lbs of Best diagonal and packed three pumps. Cost of packing -- $10.90

Aug. 5 — Repacked same pumps with Marco diagonal. Cost of packing - - - -15.00

May, 15 — Repacked with Marco diagonal.

"Best" diagonal		Marco diagonal
117 days	Service	284 days
9⅓ cents	Cost per day	5¼ cents
$33.98	Cost per year	$19.28

a Saving of over 43%

N.B. — We have records where 250% and 300% have been saved.

MARCO Packings are manufactured by

THE CLEVELAND RUBBER WORKS,
OF THE MECHANICAL RUBBER COMPANY,
68 LISBON RD., CLEVELAND, OHIO.

They
Fit Better
They
Are Made Better
And
Will Wear Longer Than
Any Other Packing Made

WEARWELL LEATHER PACKINGS

Reduce your repair account
and
increase the efficiency of your machines.
If your dealer WILL NOT supply you,
we will sell you direct.

Write for Descriptive Booklet and Samples.

DETROIT LEATHER SPECIALTY CO., Inc.
175 Beecher Avenue,
DETROIT, MICH.

SELDEN

ZENA

High Grade Packings

Warranted free from acid or grit. A trial means an order, and an order means a re-order. Best for high speed engines, plunger pumps and hard service in general. Write for samples.

Randolph Brandt, 72 CORTLANDT STREET, **New York.**

It Lasts For Years Without Attention

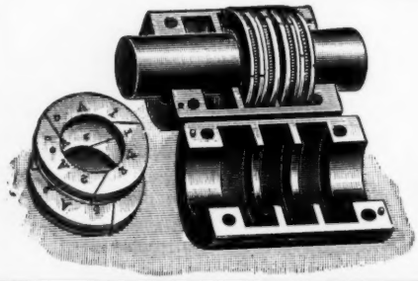
A joint made with
Goetze's Elastic Gasket

stays tight under the highest pressure of superheated steam and is not even affected by sudden changes of temperature.

Ask for a free sample giving size and purpose.

American Goetze Gasket & Packing Company,
525 E. 149th St., New York City

No Square Shoulders On Bridgeport Packing



This Improved Ring Packing has no square shoulders to limit wear of rings. It is extremely flexible, and no matter how badly engine is out of line it floats with rod and offers very little resistance. Made of cast iron. Give it a trial—it will cost you nothing if you are not satisfied with the results.

The Bridgeport Metallic Packing Co.,
629 Railroad Ave., Bridgeport, Conn.

THE PACKING WITH REAL HOLDING QUALITY

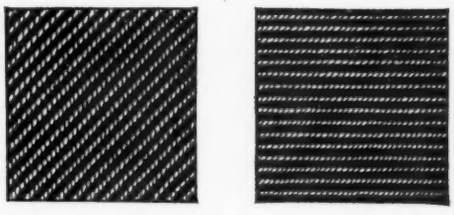
Pat. March 15
1898

DODS Diagonal Piston Rod Packing

is all one piece, made from high-grade Rubber and Duck in layers placed at a diagonal from every side. This construction gives "Dods" a cross expansion of 100%. It will hold steam, air or liquids when all other packings fail.

Send for test samples and description. Address Dept. P.

CROSS-SECTIONS OF
"DODS" PACKING. ORDINARY PACKING.

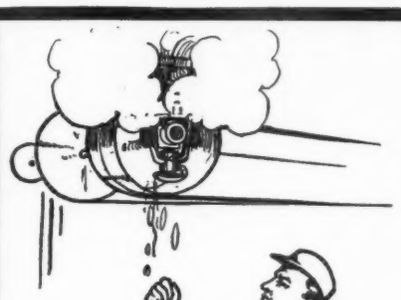


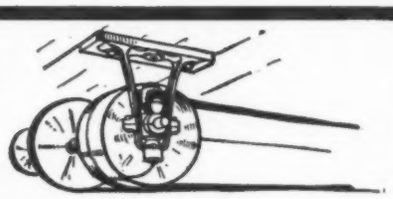
☞ These Cross-Section Views Show Why!

CHICAGO **BOWERS RUBBER WORKS** SAN FRANCISCO

THERE IS ONLY ONE

ALBANY GREASE





THE SUBSTITUTE

Nothing Worse I Can Imagine

The only Genuine ALBANY GREASE has this trade mark on every package. Look and ask for it.

Send for FREE sample cup and can of "Albany Grease," giving size of tap for cup, depth of oil hole from top of cap to journal, where to be used and firm's name.

MADE ONLY BY
ADAM COOK'S SONS,
313 WEST ST., NEW YORK.

NOTHING EZR EASIER I SEE IC

THE ONLY GENUINE

STEAM PIPE COVERING

Magnesia, Asbestos, Air Cell,
Wool Felt, Hair Felt, Mineral Wool.

Estimates given and work executed promptly.

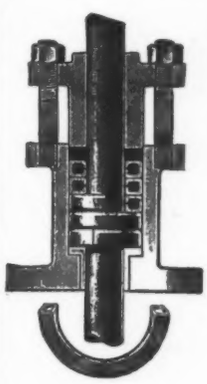
ROBERT A. KEASBEY COMPANY,
100 N. Moore Street, -:- New York City.

TORPEDO ASBESTOS PACKING

Used with wonderful success on U. S. Torpedo Boats. That's proof.

Makes tight joints where all others fail. If you use it *now* you'll save trouble later. Circular?

OSGOOD SÄYEN, 421 Arcade Bldg. **Philadelphia, Pa.**



HUHN PACKING

is positively the only packing which lubricates the rod perfectly and in exact proportion to the requirements produced by friction.

On account of this SELF LUBRICATING feature alone, this is the most economical packing on the market.

Write for a sample and our booklet.

American Huhn Metallic Packing Co.
1876 Broadway, New York

American Asbesto-Metallic Packing.

Perfect for high pressure. Semi-metallic, packs like fibrous packing, wears like metallic and gives more satisfaction than either. Ask us just how it is made, or, better yet, get a sample and see for yourself.

American Steam Packing Company,
51 High Street, Boston, Mass., U. S. A.

The Improved

Tripp Metallic Packing

Manufactured Solely By

TRIPP METALLIC PACKING CO. 74 India St. Boston, Mass.

A Pound of Packing

that does the work is worth a ton of the trouble making kind.

With Johnson's Packings a little goes a long way and gives satisfaction at every point. *Write.*

The HENRY JOHNSON COMPANY,
175-187 Gates Avenue, Jersey City, N. J.

We're So Anxious To Have You Try

ANTI-CORROSIVE CYLINDER OIL — REGISTERED IN PATENT OFFICE UNITED STATES CANADA AND GREAT BRITAIN — MANUFACTURED ONLY BY E. H. KELLOGG & CO. 243-245 SOUTH ST. NEW YORK, U.S.A.

that we'll send you a barrel and let you use it for 90 days. When "time is up" if you do not think it is worth every cent of *our* price just name your own and we'll accept your check for the amount.

Anti-Corrosive Cylinder Oil is *cheap*, when figured by the year. It saves 50% in quantity over "cheap grades" and saves your piston packing. Contains no acid and will neither corrode or gum. Prevents scored cylinders and eliminates boiler troubles. *Write!*

E. H. Kellogg & Company,
243 South Street, New York, N. Y.
8 B Rumford Court, Liverpool, England.
ESTABLISHED FIFTY YEARS AGO

TRADE MARK REGISTERED IN UNITED STATES PATENT OFFICE
NON-FLUID OILS

have solved the problem of truly economical engine and machine lubrication.

NON-FLUID OILS do not drip and spatter like fluid oils.

NON-FLUID OILS are exactly what their name implies, fluid oils, rendered non-fluid.

NON-FLUID OILS are economical—they do not waste—every bit that is fed STAYS in the bearing and LUBRICATES.

NON-FLUID OILS do not increase friction and wear and tear like greases which require heat to soften them.

NON-FLUID OILS are made in over forty (40) different densities for all pressures and all speeds of bearings.

IT WILL PAY YOU TO ADOPT NON-FLUID OILS

SAMPLES FREE

ORIGINATORS AND SOLE MANUFACTURERS OF

NON-FLUID OILS

THE NEW YORK AND NEW JERSEY LUBRICANT CO.
Dept. A, 14-16 Church Street, New York City

54-C

HARRIS

TRADE MARK REGISTERED

OILS

FOR SUPERHEATED STEAM.

Our S. H. VALVE OIL represents the results of practical experience in the lubrication of Cylinders where Superheated Steam is used. This oil has high flash test, excellent body and adhesiveness, thus affording the most satisfactory and economical lubrication.

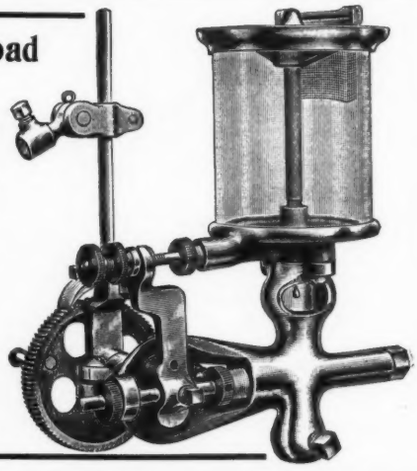
A. W. HARRIS OIL CO., 323 So. Water St., Providence, R. I.

The Royal Road To Lubrication

Manzel Force and Sight Feed Oil Pump runs by the engine's reciprocating motion and consequently feeds perfectly to the engine's need.

Write now!

Manzel Bros. Company,
326 BABCOCK ST.,
Buffalo, New York



1876—1908

The Fidelity and Casualty Co. Of New York.

George F. Seward, President — Robert J. Hillas, Vice-President and Secretary.

The Company grants insurances as follows:

FIDELITY BONDS	STEAM BOILER
EMPLOYERS' LIABILITY	ELEVATOR
PERSONAL ACCIDENT	FLY-WHEEL
HEALTH	BURGLARY

PLATE-GLASS

In the Fidelity, Boiler, Elevator, and Fly-Wheel lines careful inspections are made by experts.

Capital:	Surplus:
$1,000,000.	$1,013,400.24.

Steam-Boiler Insurance.

The operator of steam boilers is more interested in prevention of loss than he is in reimbursement for loss.

Hence the great importance of efficient inspection service to him.

In choosing a company therefore in which to place his steam-boiler insurance, he should give the order to that one which by reason of experience and general fitness is competent to make proper inspections.

This company has been inspecting boilers for more than a quarter of a century and is fully equipped to render efficient service.

Write to us for particulars.

Home Office, 97-103 Cedar Street, New York.

The Oil One Saves Would Pay For Ten Or More.

The Acme Oil Filter

is simply constructed, charged with pure animal bone black and guaranteed to return more clear effective lubricant for your waste oil than any other filter. *Write.*

We Send It On Trial.

WALTER L. FLOWER
STEAM SPECIALTY COMPANY
311 So. 8th St., ST. LOUIS, MO.

NEW MODEL "M"

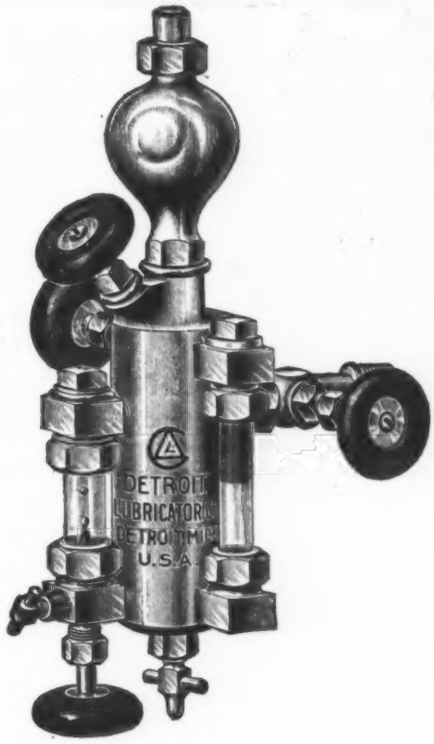
Richardson Sight Feed Oil Pump

To those interested in the details of construction, a story about the kind of material used and the valuable improvements incorporated, will be found in bulletin No. 109. May we send you one?

Mfd. by

Sight Feed Oil Pump Co.,

Milwaukee, Wis., U. S. A.



THE CROOKED DEALER

who tries to palm off some other Lubricator than a genuine **DETROIT,** is really no more foolish than the power plant man who accepts the substitute.

In the Dealer's case, he loses all chance of a re-order, while the customer "gets stuck."

Detroit Lubricators depend upon natural laws for their operation. They are economical in the use of oil. Over 950,000 are in use today. We'll send you one for a 20 days' free trial. If you don't like it, send it back. *Catalog?*

Detroit Lubricator Co.

Detroit, U. S. A.

A Sterling Force Feed Lubricator

will prove to you the advantages of the force feed system of lubrication as compared with the hydrostatic system. With a Sterling Lubricator every drop of oil is **pumped** to the right place at the right interval. No guess work; no waste of oil. Perfect Lubrication.

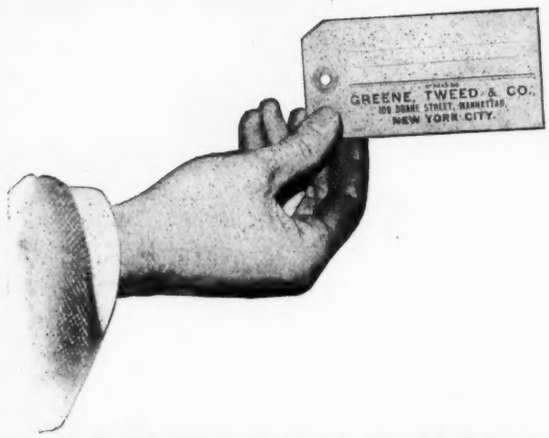
Catalog?

Sterling Lubricator Co.,
3 Frank St., Rochester, N. Y.

Send for
Nugent's Valuable Treatise on
HOW TO OIL AN ENGINE
and large catalog No. 7 A of new and
Up-to-date Oiling Devices for Hot Members

WM. W. NUGENT & CO.
18-30 W. Randolph St., Chicago, U. S. A.
Rimington Bros., Carlisle, England, Agents.

DODGE MANFG. CO., MISHAWAKA. IND.
Manufacturers of
Highest Grade Diamond D
Power Transmission Machinery and
Eureka Water Softening and Purifying Apparatus.



MAY WE WRITE YOUR NAME ON ONE OF OUR TAGS
and send you one of our

LATEST **IMPROVED**
ROCHESTER
AUTOMATIC **LUBRICATORS**

on 30 days' trial?

We will agree to pay for the transportation both ways, provided at the end of 30 days' trial the lubricator has not resulted in better lubrication, a great saving of oil and your personal satisfaction.

Try one to-day.

GREENE, TWEED & CO.,
109 Duane Street, NEW YORK.

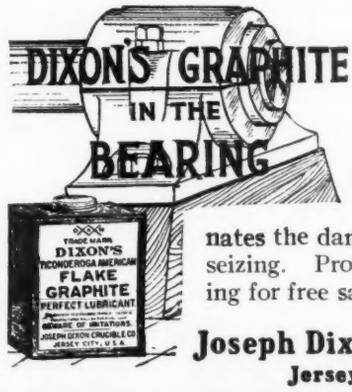
STARRETT TOOLS ARE STANDARD

Lasting Satisfaction

There is a LASTING SATISFACTION about using the best tools made—satisfaction to you—satisfaction to those who use the product of your labors.

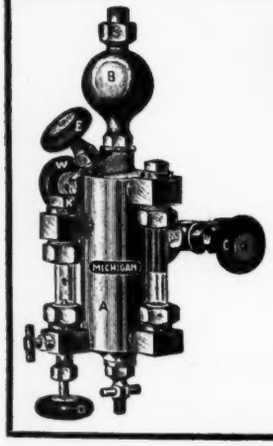
Ask for Catalog No. 18AG—the catalog of "lasting satisfaction" tools.

THE L. S. STARRETT COMPANY,
ATHOL, MASS., U. S. A.



This absolutely pure lubricant is the most perfect friction reducer known. It prevents excessive wear in any bearings and eliminates the dangers of cutting and seizing. Prove its merit by sending for free sample can No. 94-C.

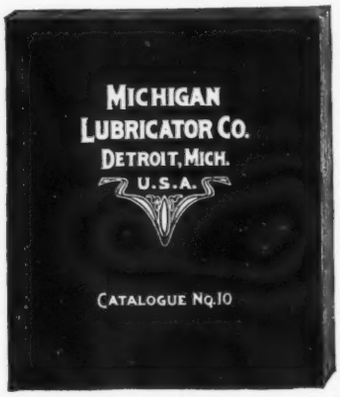
Joseph Dixon Crucible Co.
Jersey City, N. J.



Michigan Lubricators

ENGINEERS
WE WANT YOU TO HAVE A COPY OF OUR No. 10 CATALOG—108 PAGES
—SENT FREE—

MICHIGAN LUBRICATOR COMPANY
DETROIT, MICHIGAN.



"Edge-on" LEATHER BELTING

PATENT LAMINATED BELT * CEMENTLESS LAPLESS ENDLESS * C CAN'T FAIL F A

U. S. Patent Dec. 3, 1907

PATENT LAMINATED BELT * CEMENTLESS LAPLESS ENDLESS * C CAN'T FAIL F A

U. S. Patent Dec. 3, 1907.

Note the Difference in Pliability Between "Edge=on" and Cemented Belting

The illustration shows how the same pressure that will bring the ends of a piece of "Edge-on" together only makes a "horse shoe" of cemented belting. And this shows very clearly the superior pliabilty and flexibility of "Edge-on."

An entirely new principle is employed in making this laminated belting. It is made of strips, each one a single piece sewn through and through across their width, and no cemented joints are used. Thus "Edge-on" has a natural curve to fit the pulley, which prevents the outside from stretching and the inside from crowding, and which increases the friction 50%.

"Edge-on" is more durable, more capable of pulling heavy loads, and has greater cohesion than any other belting made. If you are having trouble with your power transmission problems, "Edge-on" offers you a certain and immediate solution.

LAMINATED BELTING COMPANY,

Chicago Branch, 44-46 Franklin St. **51 BEEKMAN STREET, NEW YORK CITY.**

We're Going to Raise Your Salary

"Yes, young man, we find that the training you have applied to your work has been so beneficial to the Company that we are going to encourage your further efforts by raising your salary."

Such scenes as these are actually taking place every day. The man who gets the raise is the **trained** man—the expert—while the untrained man plods along at the same old wages. If **you** are poorly paid and have ambition, there is a practical and definite system by which you can obtain promotion—a system that last year brought over $20,000,000 in increased salaries to the men that adopted it.

You won't have to leave home; there'll be no interruption in your work; there's no age limit; you won't have to buy books; it makes no difference what you do or where you live; lack of capital is no barrier; it makes no difference how scant your spare time may be.

If you are ambitious, mark and mail this coupon **NOW** and find out the most practical way to raise your salary.

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 979, Scranton, Pa.

Please explain without further obligation on my part, how I can qualify for a higher salary and advancement to the position before which I have marked **X**.

Electrical Engineer	Machine Designer	Sanitary Engineer
Elec.-Lighting Supt.	Mechanical Draft.	Architect
Elec.-Railway Supt.	Foreman Machinist	Architectural Draft.
Electrician	Foreman Toolmaker	Ad Writer
Telephone Engineer	Foreman Molder	Window Dresser
Civil Engineer	Foreman Blacksmith	Chemist
Bridge Engineer	Marine Engineer	Sheet-Metal Draft.
Mechanical Engineer	Hydraulic Engineer	Ornamental Design.
Stationary Engineer	Municipal Engineer	Textile Designer
Gas Engineer	R. R. Construc. Eng.	Bookkeeping
Refrigeration Eng.	Surveyor	Stenographer
Traction Engineer	Mining Engineer	Civil Service Exams.

Name _____

St. and No. _____

City _____ *State* _____

B I G

Are the Costs of Motor Troubles SMALL

The Cost of Their Solution

Ever been troubled with motor troubles? Ever sat up nights, worked Sundays and holidays trying to trace the source of trouble? Ever had to say "skunked" to yourself and the front office? Ever had to give it up and send for an expert?

Time, Tide and Motor Troubles are brothers in this: They're sure to happen!

BUT—and this is a big "but"—we have published a book that will relieve you of about 90 per cent. of the worry and difficulty attendant upon motor troubles. It shows the simplest and most effective methods of tracing and correcting direct- and alternating-current motor troubles and the testing of direct and alternating-current machinery. And it was written by the greatest expert of them all—a man who knows motors from start to finish—E. B. Raymond, Electrical Engineer, General Electric Co. The book's title is

Motor Troubles

Every engineer should have it. It is so indexed that when trouble arises, reference can be made and the methods of tracing and connecting the difficulty can be found instantly. If a motor trouble happens that this book doesn't discuss, it's because it hasn't been invented yet. Surely you can see the value of this book to you. Its cost is $1.50, postpaid. If you'll send us your order, with the price of the book, TODAY we'll guarantee you entire satisfaction. If you're not satisfied and return the book in good condition within 5 days of receipt, we'll refund your money.

Bound in cloth, 200 pages, 5x7, fully illus.

Hill Publishing Company

505 Pearl Street, New York City

Power *American Machinist*

The Engineering and Mining Journal

¶ No amount of adjusting will make an inferior belt do the work of a Rhoads Belt.

Rhoads Leather Belting

is right in the making, and stays right. Side by side with others is the place to find out its value.

J. E. RHOADS & SONS

Philadelphia: 12 No. Third Street
New York: 40 Fulton Street

Boston: 105-111 Summer Street
Hamblet & Hayes Co., Eastern Agents

FACTORY AND TANNERY, WILMINGTON, DELAWARE

OXOILOX

will make any belt pliable and tough.

It drives out the old sticky dope that never can do any good, and restores to leather the natural strength and vitality lost in tanning.

OXOILOX is a leather food and preservative, not a drug.

All it does is to keep leather soft and strong and tough, so that it clings closely to the pulleys. But that is the whole theory of correct belt practice. Belts should cling so closely to pulleys that air is excluded from between the two surfaces. The partial vacuum thus formed makes slipping almost impossible and enables belts to do their full duty running slack.

OXOILOX is Nature's remedy for slipping belts.

FREE

F. S. WALTON CO., Philadelphia, Pa.

Gentlemen:—Kindly send me, free of charge, a Sample Can of OXOILOX, the perfect belt dressing.

Name .....

Name of Firm .....

Address .....

Number of belts .....

Average size .....

F. S. WALTON CO., PHILADELPHIA, PA.

PRESSERS AND REFINERS OF ALL GRADES OF NEATSFOOT OIL

1,000,000 In Use

transmitting more power by 33% than metal pulleys having the ordinary plain face.

The American Pulley

has grown so popular that it is carried in stock in more than 100 cities in this country and in all the large cities throughout the world. *Write.*

Patented in the United States and foreign countries.

The American Pulley Company

29th and Bristol Streets, Philadelphia, Pa.

THE GENUINE GANDY

A TOUGH PROPOSITION

so far as durability is concerned—the above is true of

GANDY RED STITCHED COTTON DUCK BELTS.

They seem to last forever—and that's not all—from start to finish they run straight and true, and cling smoothly and closely to the pulleys. No slipping. "But the cost"? **BARELY 1-3 THAT OF LEATHER BELTS.** They certainly are money savers, and our free booklet "*Experiences with Gandy*" tells how and why.

MAURICE GANDY
FOUNDER OF THE GENUINE
RED STITCHED COTTON
DUCK BELTING

¶ Gandy Belt Dressing maintains the high standard set by Gandy Belts.

THE GANDY BELTING CO.
BALTIMORE MD.

WHERE TO USE AQUA RAWHIDE BELTING.

OIL-STEAMPROOF "Aqua" WATERPROOF

If steam or wet weather makes your belts stretch beyond all reason,

If your belts slip and ruin because oil or water drips upon them, or

If your rubber, duck or so-called "waterproof" oak-tanned belts have gone to pieces or won't keep your machines running regularly,

The one belting that will do your work and do it right is

Shultz Aqua Waterproof Belting.

Get an Aqua Belt for 60 days' free trial.

We also make **SABLE** Rawhide Belting for ordinary dry drives.

SHULTZ BELTING CO.,

ST. LOUIS, MO.

NEW YORK BOSTON PHILADELPHIA

No. 26

Cling-Surface is a preservative treatment for belts and ropes, a food, which penetrates into them, making and keeping them pliable, waterproof and preserved—not sticky, prevents all drying out or cracking.

And at the same time stops all slipping so all belts or ropes can be run easy or slack and carry fullest loads.

You can't do this without Cling-Surface and we guarantee results. Write us.

Cling-Surface Company

1049 Niagara Street Buffalo N Y

New York Boston Denver Atlanta
Chicago St. Paul St. Louis Memphis
London Thomas & Bishop 119-125 Finsbury Payment E C

The Philips Pulley once you try,
No other pulley you will buy.
All must admit this stubborn fact,
Its entire face gives belt contact.
No rivets penetrate the face;
The spider's strong, 'twill stand the pace;
The Philips Pulley, subtantial and true
Is the proper pulley your work to do.

PHILIPS PRESSED STEEL PULLEY WORKS

4th Street and Glenwood Avenue, Philadelphia, Pa.

TRADE MARK

GET THE PHILIPS *ASK FOR CATALOG*

Robins Laminated Leather Belting

Eliminates The Glue Pot

SOLVES THE BELT PROBLEM.

The Scientific Principle:

Continuous strands are spirally cut from the choicest leather locations of the belting butt to exact mechanical gauge. The strands are then separately stretched to the extreme elastic limit and assembled on edge forming a belt of any practical length, width or thickness. Made endless on pulleys with a simple interlocking splice.

The Positive Result:

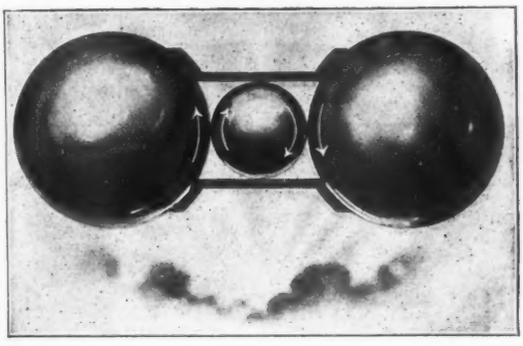
A continuous belt without laps, plies or cement. Absolute uniformity of strength, gauge, balance and flexibility. Complete adjustment to varying pulley conditions with the maximum of surface and circumferential contact. Remarkable power transmission and highest productive efficiency.

Write for Circular No. 2 giving detailed description.

ROBINS NEW CONVEYOR COMPANY

NEW YORK, **38 Wall Street.** *FACTORY,* **168 Duane Street, N. Y.** *CHICAGO,* **Old Colony Building.**

Take Out Your Ring Oiling Bearings and Install The "Chapman" We Guarantee Results



It's easy to cut down coal bills, oil bills and belting provided you awake to the true value of Chapman Double Ball Bearings and install them in your plant. They require no oil, demand no attention and will run for years and years without a thought. Your power CAN'T leak out through them—they work WITHOUT FRICTION. Cool under the heaviest loads.

Write for a Catalog.

CHAPMAN BALL BEARING CO.,

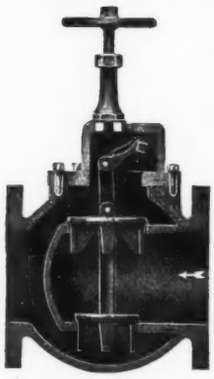
40 Bristol St., BOSTON.

PRESSURE REDUCING VALVE.

DAVIS VALVE SPECIALTIES

Will Prove Their Value to You

BEING SOLD STRICTLY ON THEIR MERITS, they must make good or be rejected. There is no chance of your being forced to pay for an inefficient device, for every Specialty that goes out of our factory is on approval. Then we leave you to judge by actual service test whether the GOOD VALUE reputation of **DAVIS VALVES** is true or false. Your interests are protected and we can only hope to secure your business by the unquestionable merit of our goods.

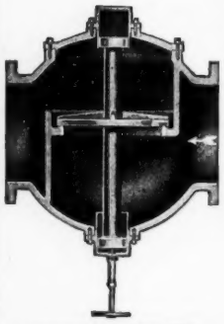


BOILER STOP AND CHECK VALVE.

WE MAKE PRESSURE REDUCING VALVES, EXHAUST RELIEF VALVES, BOILER STOP AND CHECK VALVES, BACK PRESSURE VALVES,

Float Valves, Steam Traps and other Power Plant Specialties, which are fully described in our new 1908 general catalog just issued. Send for a copy now, and select the device you wish to have sent on approval for test in your plant.

JOBBERS EVERYWHERE SELL DAVIS VALVES.

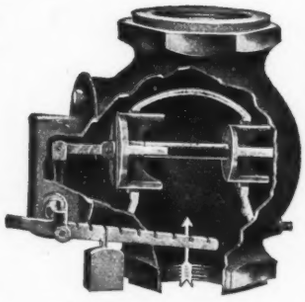


HORIZONTAL EXHAUST RELIEF VALVE.

G. M. Davis Regulator Company,

142 Milwaukee Ave., CHICAGO.

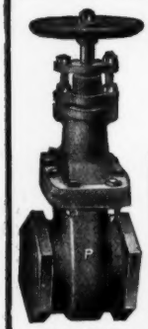
NEW YORK 123 Liberty St. BOSTON 104 High St. ST. LOUIS 735 S. 4th St. SAN FRANCISCO 216 California St. PHILADELPHIA 56 N. 2d St.
PITTSBURGH, 1206 Park Bldg.



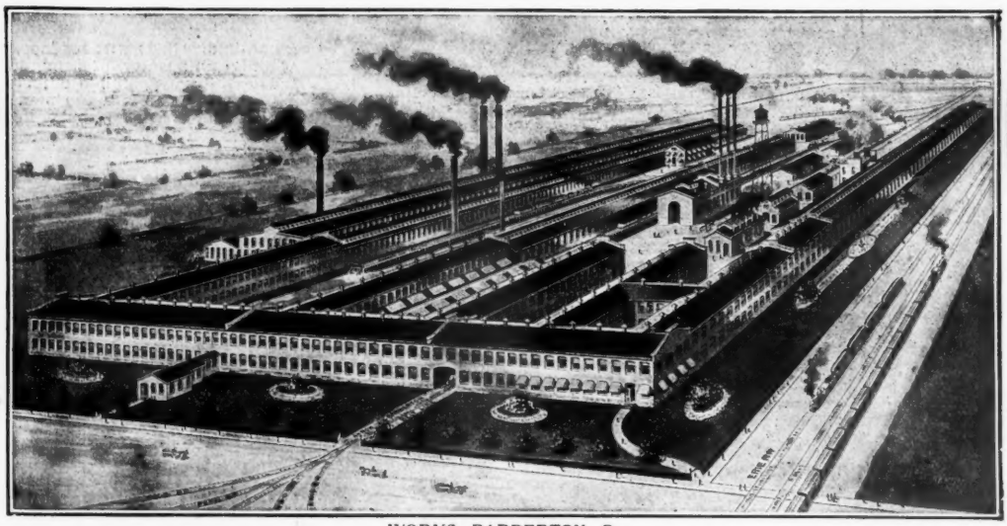
NOISELESS BACK PRESSURE VALVE.

PITTSBURGH IRON BODY GATE VALVES

have been thoroughly tested under the most severe conditions known and have proved that they work under all pressures with less wear on the faces of the discs and seats than any other valves made.

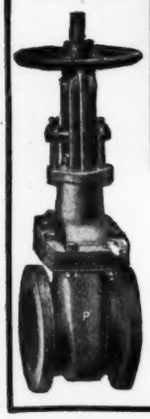


ALWAYS SPECIFY **P** VALVES AND FITTINGS.



WORKS, BARBERTON, O.

ALWAYS SPECIFY **P** VALVES AND FITTINGS.



They are made standard for 150 lbs. and extra heavy for 250 lbs. working pressures. They can be furnished screwed, flanged or hub end; with by-pass, spur or bevel gearing and are suitable for steam, gas or water. They are made with outside screw and yoke or non-rising spindles. We have many thousands of them in use in all parts of the country and have never had a complaint or a valve returned.

PITTSBURGH VALVE & FITTINGS COMPANY,

General Offices and Works: BARBERTON, O. We Manufacture all kinds of Valves and Fittings.

NELSON VALVES

FOR SUPERHEATED STEAM

Every line in the design—
Every ounce of metal—
Every touch in the manufacture—

of the Nelson Steel Gate Valve for Superheated Steam is the result of patient, careful and thorough study of its exacting requirements.

The design is absolutely new, and embodies every feature necessary to make the valve indestructable, fool-proof and tight.

The body and bonnet are of a special grade open-hearth steel of 65000 pounds tensile strength; and the trimmings—including the stem and all working parts—are of almost pure nickel, a composition perfectly non-corrosive and exceeding the open-hearth steel parts in strength.

The cork-handled hand-wheel facilitates ease and comfort of operation; the special swing-bolted stuffing box is protected from the extreme heat by elongated condensing chambers, so that they can be comfortably packed when open.

They are guaranteed—absolutely and expressly—to successfully withstand the extraordinarily destructive action of steam at high pressures and temperatures.

Full details on application.

Nelson Valves are made in the Gate, Globe, Angle and Check types, in all sizes, of Iron, Bronze or Steel, for all pressures, for any service.

THE NELSON VALVE COMPANY
PHILADELPHIA, PA.

NEW YORK	HUDSON TERMINAL BLDG.
CHICAGO	40 DEARBORN STREET
PITTSBURGH	525 THIRD AVENUE
MINNEAPOLIS	622 ANDRUS BLDG.
SAN FRANCISCO	ATLAS BUILDING

IF YOU ARE AN EXPERT VALVE MAN

you buy only

NEW BEDFORD QUALITY VALVES

because you know them to be the best ever made. If you are not expert you buy them because you need the guarantee of the most reliable house to back your own judgment.—*Write.*

New Bedford Boiler and Machine Co.

Est. 1872

New Bedford Mass.

VALVES

Makes no difference what kind of a Valve you want, how you want it made or where you want it shipped, we can supply it on shortest possible notice.

We manufacture Valves, and Pipage Equipment of every description, for all kinds of plants, Steam Separators, Tuyere Cocks, Brass Unions, etc. Also make Pipe Bends, and do all kinds of Pipe Fitting, either assembled or ERECTED.

Send for catalog.

PITTSBURGH VALVE FOUNDRY & CONSTRUCTION CO.,

Pittsburgh. Cleveland. New York. Boston.
Birmingham, Ala.

YORK MANUFACTURING CO.,
YORK, PA.

We manufacture all the machinery and parts needed to equip a complete Ice or Refrigerating Plant—Machines, Condensers, Tanks, Cans, Coolers, Piping, Boilers and Ammonia Fittings of all kinds.

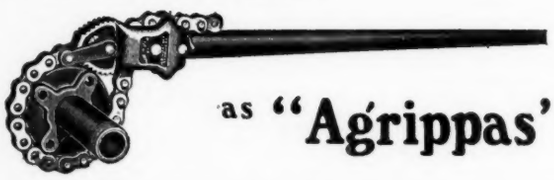
We employ over 1250 men in the manufacture of Ice and Refrigerating machinery exclusively.

CATALOG UPON REQUEST.

Our fittings carried in stock at the following places:

York Manufacturing Co.,	1660 Monadnock Block,	Chicago, Ill.
York Manufacturing Co.,	72-76 Trinity Place,	New York, N. Y.
York Manufacturing Co.,	20 South Main St.,	St. Louis, Mo.
York Manufacturing Co.,	318 Liberty Ave.,	Pittsburg, Pa.
York Manufacturing Co.,	13 S. Forsyth St.,	Atlanta, Ga.
Wegner Machine Co.,	Perry and Mississippi Sts.,	Buffalo, N. Y.
United Iron Works,	231 E. Second St.,	Los Angeles, Cal.
United Iron Works,	Second & Jefferson Sts.,	Oakland, Cal.
United Iron Works,	109 Main St.,	Seattle, Wash.
Braman, Dow & Co.,	239-245 Causeway St.,	Boston, Mass.

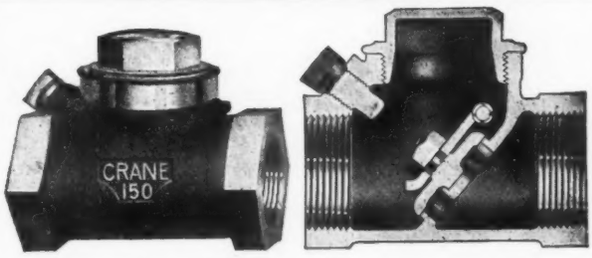
As insistent



as "Agrippas"

as we may seem on question of Chain Pipe Wrenches, we believe the course O. K. Every job has its kinks and irregular, close or cramped fittings, too cramped for other tools with two jaws. Agrippas have one jaw, all the strength and "get there" on any kind of work. Agrippas are practically two tools in one because of utility. Discount and free trial from your dealer.

J. H. WILLIAMS & CO., SUPERIOR DROP FORGINGS,
BROOKLYN AND CHICAGO.



STRAIGHT-WAY CHECK VALVES

WITH REGRINDING SEATS

THESE valves are designed for the most exacting service, on pressures up to 150 pounds. All parts are made of a superior bronze mixture. The distribution of metal gives ample strength without unnecessary weight.

Valves have full area and operate horizontally or vertically.

The seat is placed at such an angle that the force of impact of disc is reduced to the minimum, decreasing wear on disc as well as noise of hammering.

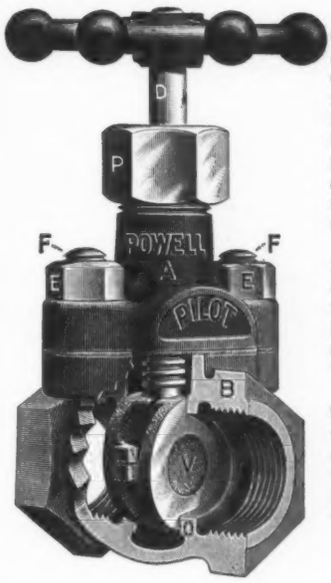
Side hub and disc-stop are made up with tapered joints to overcome the tendency to leak at these places.

Regrinding is a very simple operation and requires but a few minutes.

Made in sizes up to 3 inch, screwed or flanged.

CRANE CO.,
CHICAGO.
ESTABLISHED 1855.

The Powell PILOT
BRASS MOUNTED GATE VALVE



A DOUBLE DISC Iron Body Gate Valve for medium pressures. The body is strong and compact with heavy lugs carrying stud bolts E. The stud holes in lugs of bonnet cap A, being accurately drilled to template, permit the valve to be assembled any old way. No matter how you handle it, after taking apart, it always fits.

THE DOUBLE BRASS DISCS, made adjustable by ball and socket back, are hung in recesses to the collar on the lower end of the stem. Stem is cut to a true acme thread, the best for wear.

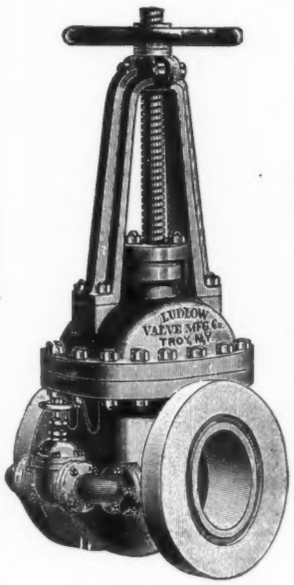
The Powell Pilot Gate Valve is also made all iron. For the control of cyanide solutions, acids, ammonia, and other fluids that attack brass it has no equal. Send for special circular.

If YOUR jobber does not have them in stock —ask us who does.

THE WM. POWELL COMPANY
CINCINNATI, OHIO.

NEW YORK, 254 Canal St. PHILADELPHIA, 518 Arch St.
BOSTON, 239-245 Causeway St.

LUDLOW VALVES
FOR EXACTING SERVICE



are valves that do more than simply *pass muster.*

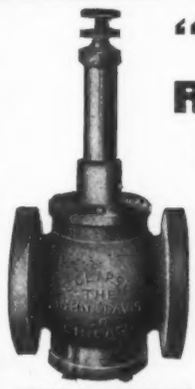
They are positively the best that can be produced, as to design, material and workmanship.

Built for hard use under severe conditions.

Investigate the merits of "Ludlow Valves."

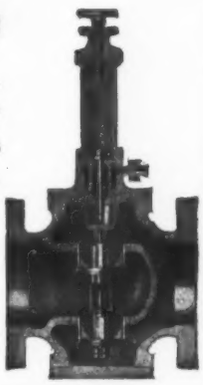
Catalog for the asking.

THE LUDLOW VALVE MANUFACTURING COMPANY,
ADAMS STREET, TROY, N. Y., U. S. A.



"ECLIPSE" Regulating Valves Regulate

We make Regulating Valves for all conditions and all service.



"THE HUGHSON ECLIPSE"

is the best valve for close regulation and where the steam pressure is not constant, such as reducing the steam pressure for Engines, Pumps and Dynamos.

"ECLIPSE" Steam Specialties

"ECLIPSE"
- Reducing Valve
- Low Pressure Regulating Valve
- Back Pressure Valve
- Vacuum Pressure Regulating Valve
- Automatic Pump Governor
- Pump Regulator

Distinctive points of merit in principle of construction, supported by the best of material and superior workmanship—count for the satisfactory performance of every device in use.

CATALOG of detailed information covering our complete line on request

JOHN DAVIS COMPANY
HALSTED, 22ND and UNION STREETS, CHICAGO

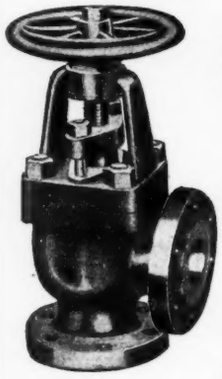
W. G. Ruggles Co., Boston. Western Valve Co., St. Louis
Central Supply Co., Indianapolis, Ind.
Robert B. Orr Engineering Co., Kansas City, Mo.
J. A. Roe & Co., Detroit, Mich. A. M. Lockett Co., New Orleans, La.
Jas. H. Pearson, 122 Centre Street, New York City.

UNEVEN SURFACES

hold no terrors for **Kennedy Renewable Disc Valves.** The Valve Discs are made of a special compressible composition and readily conform to all irregularities. They are easily renewable.

Tight joints can be yours. Write for 1908 "Kennedy Valve Book."

THE KENNEDY VALVE MFG. COMPANY, Elmira, N. Y.



Manufacturers of the

EDWARD VALVE

For High Pressures, Superheated Steam and Water.

THE LAMMERT & MANN

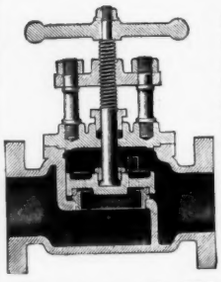
Oil Dash Pots for Corliss Engines, Gas and Gasoline Engines.

LAMMERT & MANN,

ENGINEERS and MACHINISTS,

157 S. Jefferson St. CHICAGO, ILL.

"BELLVILLE VALVES"



have the seat on the outside of an inverted cone where the direct current of steam does not come in contact with it, preventing all chance of wire drawing. Other features in catalog.

Heavy, Compact, Durable,
no marring by pipe tongs.

Eastwood Wire Manufacturing Co.,
BELLEVILLE, NEW JERSEY.

THREE-REASONS FOR USING THIS THREE-WAY VALVE

1—Because it is a *Homestead Valve.*

2—Because the seats are absolutely protected from wear.

3—Because its durability is phenomenal.

Write for Catalog.

Homestead Valve Mfg. Company,
Pittsburg, Pa., U. S. A.

"TWO VALVES IN ONE"

"THE ANDERSON"

CUSHIONED NON-RETURN AND TRIPLE ACTING

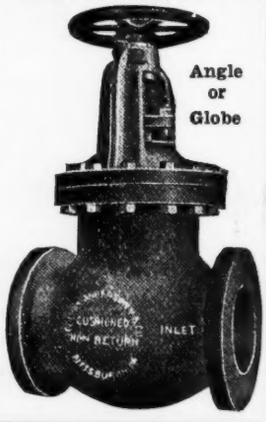
"WORKS BOTH WAYS"

"The Life and Property Insurance Valves"

Protect Your Power Station with the Valves that are Absolutely Guaranteed.

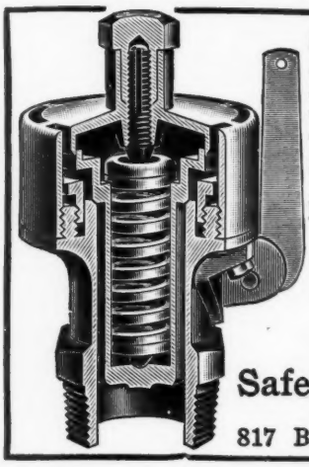
References:

National Tube Co.
Armour & Co.
Illinois Steel Co.
American Steel & Wire Co.
Chicago Brass Co.
H. C. Frick Coke Co.
West Va. Pulp & Paper Co.



Angle or Globe

GOLDEN-ANDERSON VALVE SPECIALTY CO.
1017 Fulton Building, Pittsburg, Pa.



Over 600,000 of Kunkle's Patent Lock-up Pop Safety Valves now in actual use.

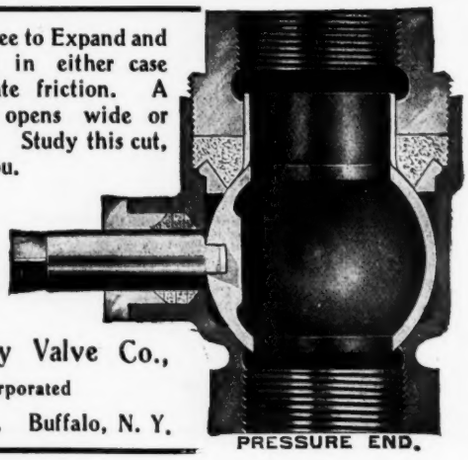
For Portable, Stationary, Locomotive and Marine Boilers. They meet every requirement. We also make Mufflers for Locomotives. Write for details and prices.

Fort Wayne Safety Valve Works,

E. B. Kunkle & Co.,
817 Barr St., Fort Wayne, Ind.

The Ball is Free to Expand and Contract and in either case does not create friction. A quarter turn opens wide or closes tight. Study this cut, it will pay you.

Please mention Power when you write.



The Huxley Valve Co.,
Incorporated
145 Main St., Buffalo, N. Y.

THE MAN BEHIND THE KEY

is the only person who can change the adjustment of the **"ASHTON" LOCK-UP POP SAFETY VALVE.** It acts promptly at the right time. Catalog "P."

THE ASHTON VALVE CO., BOSTON, U. S. A.
NEW YORK St. John's House, London, Eng. **CHICAGO.**

Taylor's Spiral Riveted Steel Pressure Pipe.

Best steel pipe made for Hydraulic Purposes. 3 to 40 inches diameter.

*Furnished with improved forged steel flanges or our steel bolted joints.

American Spiral Pipe Works, Main Office and Works: Chicago, Ill. Eastern Office: 50 Church St., New York.

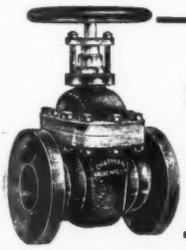
Threading an 8-inch Pipe Bend with a No. 3 "Toledo."

Why "TOLEDO" Pipe Threading Devices are constantly growing in favor.

1—They thread pipe easier than others.
2—They are light and therefore portable.
3—They are mechanically right.
4—They are the essence of simplicity.
5—They are strong and of the best obtainable materials.
6—They are inexpensive as compared with other tools not so good.
7—They are furnished with a set of dies for each size pipe, thus giving many times more die service than tools, using one set of dies for several sizes.
8—The dies are simple, and do not require a die-maker to keep them in good condition.
9—The dies are less expensive than others.
10—There are over 30,000 satisfied users.

Write us and we'll tell you more about them.

THE TOLEDO PIPE THREADING MACHINE CO.,
TOLEDO, OHIO.



TOP NOTCH PERFECTION

Chapman Valves

WRITE

CHAPMAN VALVE MFG. CO.
INDIAN ORCHARD, MASS., U.S.A.

ENGINEERS' CHUMS Needed in every Engine Room.

Set of No. 1 Mound Scraping Tools - - - - $2.50
Set of No. 2 Mound Special Hollow Ground - - $3.00
Set of 6 Mound Packing Tools - - - - - $3.25
Set of 5 Mound Cold Chisels, $3.00

Send for book "Engineers' Chums."

Erwood Swing Gate Valves

Manganesite Paste for Joints

WALCH & WYETH, 87 Lake St., Chicago.

CLIMAX & VANSTONE FLANGING • PIPE BENDING • FITTINGS • VALVES FOR ALL PRESSURES

BEST-VALVES

BEST MANUFACTURING CO. PITTSBURGH, PA.

"BALLWOOD" WELDED FLANGES

guarantee a permanently tight leakless joint.

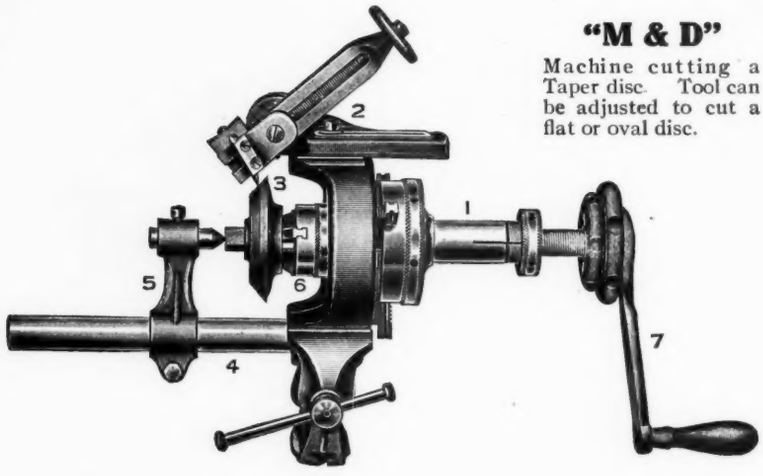
They are made of the same grade metal as the pipe and welded by a process similar to that employed by pipe manufacturers in welding lap joints. Becoming integral parts of the pipe, they expand and contract with it.

Special methods enable us to quote low prices and promise prompt delivery. Circular 104?

THE BALL & WOOD CO.,
ELIZABETHPORT, N. J.

New York Sales Office,
Cortlandt Bldg., 30 Church Street.

BUILDERS OF BALLWOOD ENGINES.



"M & D"
Machine cutting a Taper disc. Tool can be adjusted to cut a flat or oval disc.

FIRST AID TO LEAKY VALVES SAVES BUYING NEW ONES

It's no disgrace for a valve to leak. And it's really not a serious matter, *provided* you have a *Morse and Dexter Valve Reseating Machine.*

With this machine you can reseat each valve eight or ten times without breaking connections. Simply attach the machine to the valve casing, turn the handle a few times and the valve is as tight as the day you bought it.

Think of having a machine that will last a life time treating your valves over and over, year after year. Even those old valves lying around on the scrap pile can be reclaimed and put in active service again. *It's just like finding money.*

To prove all this, we'll lend you our machine for 30 days. If at the end of that time you are not firmly convinced that it will hand you back your money and keep making more for you, send it back at our expense.

Catalog "P" describes. Get a copy.

THE LEAVITT MACHINE COMPANY,
ORANGE, MASS., U. S. A.

Ohio Water Gauge

"OHIO" STEAM SPECIALTIES

ACCURATE WORKMANSHIP, CORRECT DESIGNS AND HIGH GRADE STEAM BRONZE ARE ALWAYS TO BE FOUND IN OUR STEAM SPECIALTIES. THEY ARE MADE FOR THE ENGINEER WHO WANTS HIS POWER PLANT EQUIPMENT TO BE THE *BEST OBTAINABLE* IN BOTH FINISH AND OPERATION.

CATALOG P-F TELLS ALL ABOUT "OHIO" STEAM SPECIALTIES.

CATALOG P-B TELLS ALL ABOUT OUR COLLIN STEAM PRESSURE REGULATOR

Ohio Gate Valve

The OHIO BRASS CO., MANSFIELD, OHIO

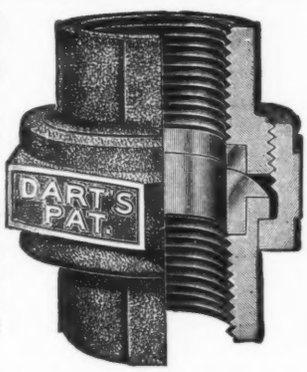
NEW YORK, 22 Cortlandt St.
CHICAGO, 277 Dearborn St.
ST. LOUIS, 10 North 4th St.
SAN FRANCISCO, 138 Front St.

As Sure To Hold As A Solid Pipe

and this is true today, tomorrow and in years to come

The Dart Union

constructed of malleable iron into which are set the spherical ball ground seats of bronze. These joints never corrode.



E. M. DART MFG. CO., Providence, R. I.

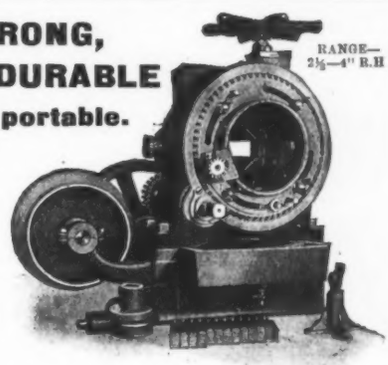
SIMPLE, STRONG, COMPACT, DURABLE

and easily portable.

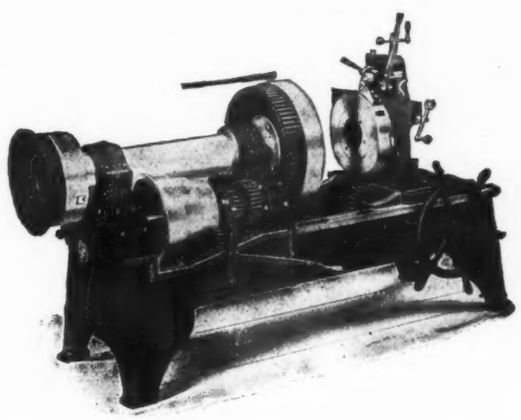
The Forbes Patent Die Stock

has revolutionized pipe cutting and threading methods.

Circular ?



THE CURTIS & CURTIS CO., 85 Garden St., Bridgeport, Conn.



Peerless No. 4 Improved Pipe Threading and Cutting Off Machine

There must be some good reason for so many duplicate orders. You'll know the reason, if you are a user of our machines. They are built for rapid and economical production and will stand the racket for years.

WRITE.

BIGNALL & KEELER MFG. CO.
EDWARDSVILLE, ILL.

MOTOR DRIVEN.

LOEW VICTOR MODEL 1908

Observe its substantial construction—its individual features.

Figure out how much time and money you can save by installing this up-to-date pipe threading machine.

You'll know then why our sales are daily increasing and why the Loew Victor is the most popular pipe machine on the market.

Made in eight different sizes and types. For the large or small pipe machine user.

Loew Feed Water Heaters--Steam and Oil Separators

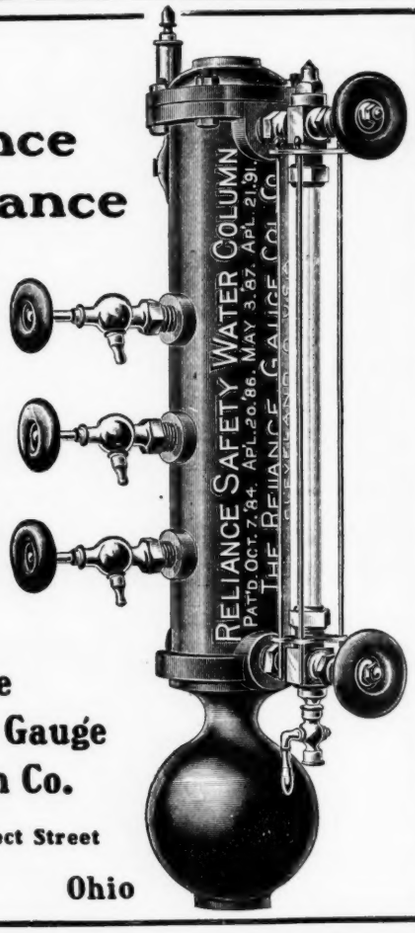
SEND FOR CATALOGS.

THE LOEW MANUFACTURING CO.,
CLEVELAND, OHIO.

This Reliance Appliance

sets loss at defiance and the way it saves money is almost a science. It causes the water to be kept at the proper level, protects boilers, insures dry steam, saves fuel, power and repairs.

Ask for catalog.

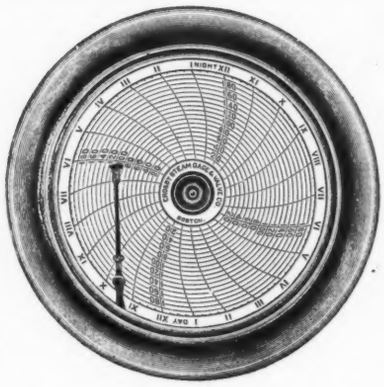


The Reliance Gauge Column Co.

75 E. Prospect Street

Cleveland, Ohio

The Compact Reliable Crosby Pressure Recorder



It is the most accurate device on the market for recording all variations of pressure which take place in a steam boiler or other receptacle and its cost is moderate.

It shows by chart, every such variation, its extent and duration and the time at which it occurs.

It is adaptable to almost any conditions and its service is perfectly satisfactory in every case.

We manufacture, also, Air Brake, Wheel Press and Mine and Draft Recorders.

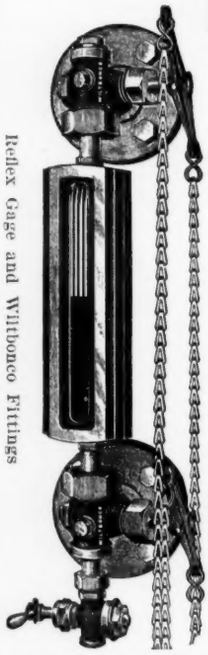
Ask for our catalog.

TRADE MARK CROSBY

Crosby Steam Gage and Valve Co.,

Boston New York Chicago London

Can You See This Black Line ?



The water in a Reflex Water Gage shows **black** just like that.

You can read the gage as easily as you see the above line.

Reflex Water Gages are used by the World's Greatest Navies. They are not affected by cold drafts of air. Easily cleaned without disconnecting and easily applied to existing fittings.

"The Water Shows Black."

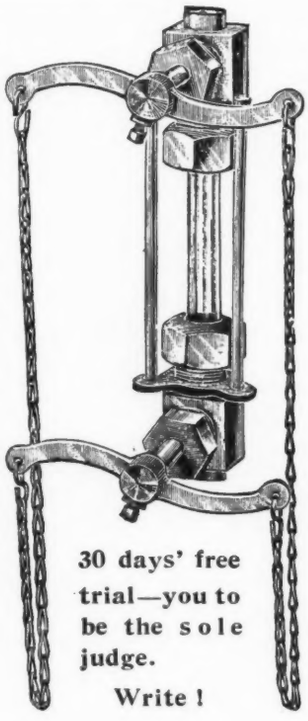
CATALOG ?

JERGUSON MFG. CO.,

219 Columbus Ave., Boston, Mass.

Successors to Wm. T. Bonner Co., Engineers and Manufacturers.

You wouldn't put your hand in the fire



and yet you're willing to risk putting it into scalding water and live steam whenever the gauge glass breaks on the old style.

The safe, sane and sensible way is to install the **"P.B.H." Quick Closing Water Gauge.** Then if the glass should break, you can stand at a safe distance, out of harm's reach, and cut off the steam and water by simply pulling a chain.

Easy! Isn't it ?

30 days' free trial—you to be the sole judge.

Write !

THE

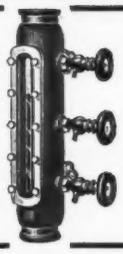
PAUL B. HUYETTE COMPANY, Inc.,

2025 BETZ BUILDING, PHILADELPHIA.

60c A Sample Box

of Gilbert Gauge Glass Preservers —the effective kind that you pack without tools.

R. F. Morse, Providence, R. I.



Reliable Water Gauges

are perfectly safe in cold air drafts and various temperatures. No bursting and scalding of hands or destruction of eyesight. *Circular?*

Reliable Water Gauge Company
1616C Pine St., St. Louis, Mo.

SECURE THE GENUINE

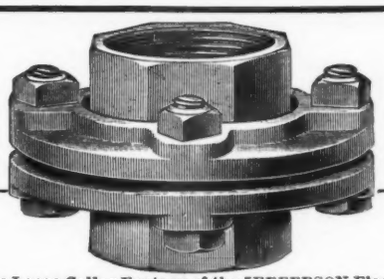
Don't let a dealer inveigle you into purchasing any other float than a genuine "Hercules."

Hercules Seamless Copper Floats

Over 240,000 are in use today. Men who *know* pay the slight extra cost for the sake of the extra good service, which means economy in the end. We guarantee each float. Catalog "B"?

HERCULES FLOAT WORKS,
P. O. Box 396. SPRINGFIELD, MASS.

SEE WHY



The Loose Collar Feature of the JEFFERSON Flange enables a positively tight connection to be made even when the pipes are out of line. The joint is *spherical* and the flat discs do not come together.

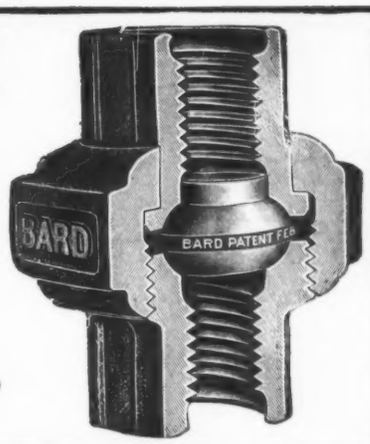
CATALOG ?

THE JEFFERSON UNION CO., 31-37 Fletcher Street, LEXINGTON, MASS.

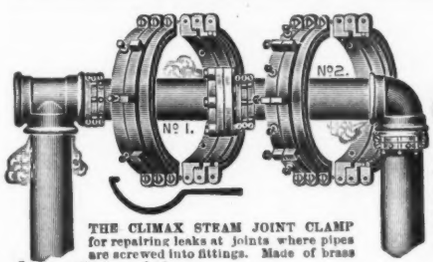
BETTER BUY THE "BARD"

Union and Flange. Can't spread because *recessed* at both ends. Note the ball ground seat each side of brass ring to absolutely prevent leakage. For the sake of a positive joint, *investigate.*

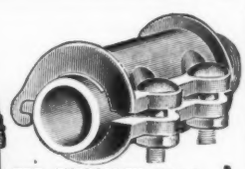
Catalog Describes.



The Bard Union Co.,
Incorporated,
Norwich, Conn.



THE CLIMAX STEAM JOINT CLAMP for repairing leaks at joints where pipes are screwed into fittings. Made of brass for all sizes of pipe.

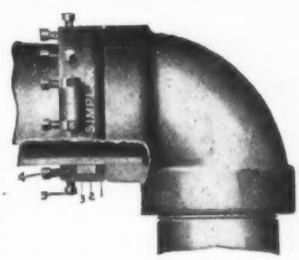


THE EMERGENCY PIPE CLAMP, for repairing splits and rust holes. Made of malleable iron from ⅛ in. to 12 inches.

PIPE REPAIRS FOR ANY CONDITION

Send for Catalog of
STEAM SPECIALTIES
JAMES McCREA & CO.,
MANUFACTURERS,
61 West Washington Street, Chicago.

Take Your Worst Leaky Joint



as a test, and while the pipe is under full pressure apply the **SIMPLEX PIPE CLAMP.** If it doesn't make the joint absolutely and permanently tight you need not pay us a cent. And we'll give you 30 days in which to *make sure.*

WRITE FOR DETAILS.

The Simplex Engineering Co.
316 Preston Street, Philadelphia, Pa.

A REAL MONEY SAVER.

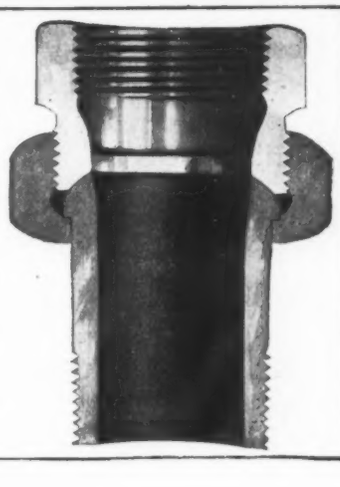
"M. & F." Pattern "KEWANEE" UNION.

Note the construction—Inside—Outside.
Note the Saving.

(a) No nipple, no gasket is used.
(b) Number of joints less than when ordinary union is used.
(c) Number of connections less, hence
(d) Labor costs materially reduced.

Note the Brass to Iron THREAD CONNECTION.

This prevents corrosion and makes it easy to disconnect or reconnect. Test it: you can figure the saving yourself.



NATIONAL TUBE COMPANY, PITTSBURGH, PA.

General Offices—Frick Bldg.

DISTRICT SALES OFFICES:

New York	Denver	Pittsburgh	New Orleans
San Francisco	St. Louis	Salt Lake City	Seattle
Chicago	Philadelphia	Atlanta	Portland

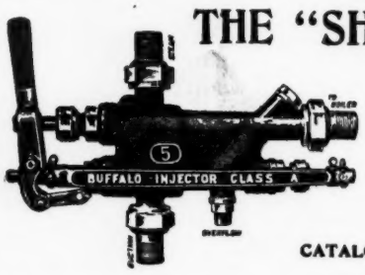
U. S. Automatic Injectors have an International Reputation for Superiority.

They have just as firm a foothold abroad as at home. Only genuine merit has placed the "U. S. Automatic" in this position. The more particular you are about securing reliable boiler feeding—the better it pleases us—for we have the **only reliable boiler feeder.**

Send for our Engineers' "Red Book"—it slips right into the vest pocket, small in size, but large in information.

American Injector Company,
Detroit, Michigan.

THE "SHERWOOD" INJECTOR



Injectors, Ejectors, Gauge Cocks, Boiler Tube Cleaners, Flue Scrapers and Blowers, Oil Cups and Pumps, Lubricators, Automatic Oil Pumps, Grease Cups, Special Brass Work.

CATALOGUE AND PRICES SENT ON APPLICATION.

SHERWOOD MANUFACTURING CO.,
BUFFALO, N. Y.
Manufacturers of Engine and Boiler Supplies.

THE "HART" OIL PUMP

A Powerful Little Device for Elevating, Conveying and Transporting Liquids—

The Garfield Ejector

Cannot be beat for raising water from deep wells, mines or pits, filling or emptying tanks, raising or transferring liquids, etc.

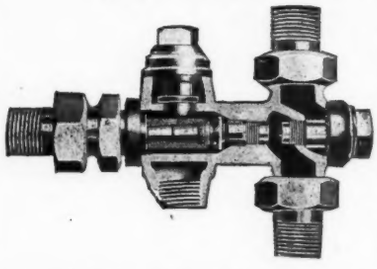
Note the straight pipe connections making it desirable for elevating water from deep driven or drilled wells

Positive in Its Work and Nothing to Get Out of Order

You cannot afford to be without it. Write for complete description. Large Catalog sent free.

The OHIO INJECTOR CO.,
The World's Greatest Injector Manufacturers,
WADSWORTH 110 Main St. OHIO, U. S. A.

The Desmond Automatic Injector The Acme Of Simplicity



As far superior to the old style complicated Injectors as modern machinery is to that of a Generation ago.

Every one fully guaranteed. Accept no out-of-date substitute. Insist upon the DESMOND. Write for Catalog.

The Desmond-Stephan Mfg. Company,
Urbana, Ohio.

AKRON CLUTCHES

DON'T WASTE POWER

Is it good policy to burn up money generating power and then not use it so as to get the full benefit? A good clutch will save its cost many times over in a year. The AKRON CLUTCH has been proved reliable and durable under the most severe duty and highest speeds. Made in all powers and for all speeds. Bulletin D, which tells more about it, sent for the asking.

The Williams Foundry & Machine Co.
Akron, Ohio
Successors to the Akron Clutch Co.

REASONS WHY

THE TRADE PENBERTHY MARK.

(Reg. U. S. Pat. off.)

AUTOMATIC INJECTOR

Always "Makes Good"

1st—It will work on higher pressure and handle hotter water.

2nd—It will lift further vertically on a greater range of pressure.

3rd—It delivers a maximum amount of water with a minimum amount of steam.

Try the PENBERTHY it never fails.

TRADE PENBERTHY MARK. **"XL-96"**

EJECTOR OR SYPHON

Has no equal in lifting or elevating liquids. Used Exclusively by the leading creameries, tanneries, breweries, brickyards, distilleries and dye houses in the country.

SPECIAL "XL-96" NON-ELEVATING EJECTOR

Heats liquids to a minimum; Lifts 28 feet; Uses less steam and delivers 33⅓% more liquid than any Ejector made. A trial will convince you.

CIRCULAR ON REQUEST.

The new "Engineer & Fireman" (80 page magazine) will be sent to any engineer who will send his name and address.

PENBERTHY INJECTOR CO.,

Largest Manufacturers of Injectors in the World

355 HOLDEN AVENUE, DETROIT, MICH.

New York Branch:—126 Chambers Street.
London, Eng. Branch:—W. H. Wilcox & Co., 23 Southwark St., S. E.

CANADIAN FACTORY:
Windsor, Ontario, Canada.

A Pipe Dream

That every Power Plant Man and Engineer indulges in, is the time when the steam pipes will cease to lose heat through radiation. For uncovered pipes cause condensation, engine troubles through wet steam and render it necessary to burn an excessive amount of fuel to counterbalance the amount of heat lost.

CAREY'S 85% MAGNESIA PIPE COVERINGS

make the Power Plant Man's dream for better things an ACTUAL REALITY.

They are composed of 85% Carbonate Magnesia and 15% Asbestos, in fibrous form. They are thorough non-conductors of heat, light, absolutely fire-proof and wear-resisting to a remarkable degree. They last as long as the pipes. The amount of fuel saved in six months will cover their initial cost.

Write for CAREY'S MAGNESIA CATALOG.

THE Philip Carey Company,

General Offices: Sta. R, CINCINNATI, OHIO, U. S. A.

Factories:

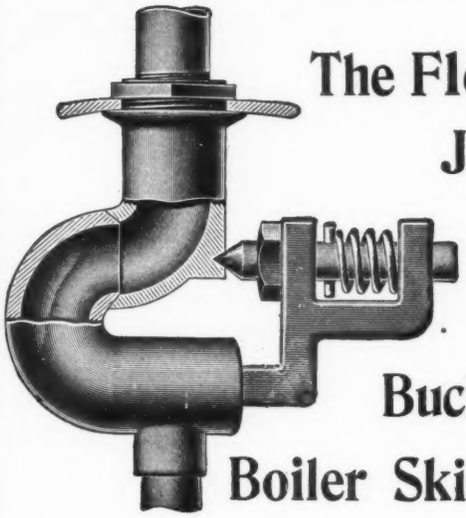
Lockland, O. Plymouth Meeting, Pa. Hamilton, Ont.

Branches and Warerooms:

Albany, N. Y., 61 State St.
Atlanta, Ga., 34 W. Alabama St.
Baltimore, Md., 434-436 N. Holliday St.
Birmingham, Ala., 2227-2229 Morris Ave
Boston, Mass., 79 Milk St.
Buffalo, N. Y, 45 Pearl St.
Charlotte, N. C., Cor. E. 7th and R. R. Sts.
Chattanooga, Tenn., 10th & Baldwin Sts.
Cleveland, O., 1460 9th St., N. W.
Dallas. Tex., Camp and Lamar Sts.
Detroit, Mich., 17 Jefferson St.
Denver, Colo., 1717 Wazee St.
Havana, Cuba, Obrapia No. 55
Jacksonville, Fla., 414 E. Bay St.
Kansas City, Mo, 526 Delaware St
Knoxville, Tenn., Hume St & South'n R. R.
Little Rock, Ark., 418-420 E. Markham St.
Memphis, Tenn., 168-172 So. Second St.
Montreal, Que., Can., 8-10 Place d'Youville.
Nashville, Tenn., 170 2nd Ave., N.
Newark, N. J., 49-51 Bank St.
New Orleans, La., 222 Chartres St.
New York City, 114-118 Liberty St.
Philadelphia, Pa., 12th & Buttonwood Sts.
Pittsburg, Pa., 333-335 Second Ave.
Seattle, Wash. 2005 Second Ave
St Louis, Mo., 918-920 No 2nd St.
Scranton, Pa., Traders Bank Bldg.
Toledo, O., 120 Summit Ave.
Toronto, Can., 112 Bay St
Washington, D. C., 1413 G St., N. W
Wheeling, W. Va., 1505 Main St.

Special Representatives and Exclusive Dealers:

Boston, C. W. Trainer Mfg. Co., 89-91 Pearl St.
Chicago, Western Roofing & Supply Co, 24th and LaSalle Sts.
Cincinnati, O., R. E. Kramig & Co., 234 E. 6th St.
Columbus, O., Columbus R. & S. Co., 116-118 E. Lafayette St.
El Paso, Tex., Mine and Smelter Supply Co.
Los Angeles, Cal., Warren & Bailey Mfg Co., 359 N. Main St.
Mexico City, Mex, Mexico Mine and Smelter Supply Co.
Milwaukee, Wis., Fred. Sprinkman Co., 146 Second St.
Minneapolis, W. S. Nott Co., 200-206 First Ave., South.
New York City, N. Y., Rbt. A. Keasby Co., 100 No. Moore St.
Omaha, Neb., Sunderland R. & S. Co., 1006-1010 Douglas St.
Pittsburg, Pa., W. A. Benits, 1472 Frick Bldg. Annex.
Salt Lake City, Utah, Mine and Smelter Supply Co.
San Francisco, Cal., Grant & Leonard, 316 First St.



The Flexible Joint of the Buckeye Boiler Skimmer

is an exclusive feature which makes it *the only device* which will satisfactorily remove all the scale-forming impurities from your water tube boiler.

The Buckeye rises and falls with the water level.

WRITE.

BUCKEYE BOILER SKIMMER CO.
SOUTH END, TOLEDO, OHIO

NO MORE SCALE provided you use **Pyramid Boiler Compound.** It is "sure death" to scale and prevents it from forming. Nothing injurious. *Write.*

Binghamton Boiler Compound Co.
BINGHAMTON, NEW YORK.
Los Angeles, Cal.; Seattle, Wash.; Portland, Oregon; Cincinnati, Ohio; Cleveland, Ohio; Providence, R. I.; Syracuse, N. Y.; Scranton, Pa.; Louisville, Ky.; St. Louis, Mo; Birmingham, Ala.

CRANES For Power Stations and Shops. Coal Storage Hoisting and Conveying Plants.

Electric and Hand. Catalog Free. Electric Traveling Trolley Hoists and Tracks.

New York:—120 Liberty St.
Philadelphia:—Land Title Bldg.
Chicago:—405 Monadnock Blk.

NORTHERN ENGINEERING WORKS,
5 Chene St., Detroit, Mich., U.S.A.

If you don't care to invest
Get a sample on request,
It is easy to apply
And its lustre will not die.

3 oz. Box, 10 cts.
5 lb. Pail, $1.00.
1 gal. Liquid, $1.00.
AT DEALERS.

U.S. METAL POLISH
G. W. Hoffman, Sole Prop. 295 E. Wash. St.
INDIANAPOLIS, IND.
TRADE MARK.
INFALLIBLE
FOR POLISHING GOLD, SILVER, PLATED WARE, NICKEL, TIN, BRASS, COPPER, Etc.
DIRECTIONS:
Take a little of the Polish on a soft cloth, rub the Metal hard and then wipe it off with a dry cloth

GEO. W. HOFFMAN—Expert Polish Maker,
295 East Washington St., Indianapolis, Ind.
New York City. Chicago, Ill. San Francisco, Cal.

REMEMBER

BIRD=ARCHER

when you order

BOILER COMPOUNDS

and you can forget your scale troubles.

BIRD-ARCHER COMPOUNDS are the best possible boiler protection because they are made up specially for each case and recommended only after careful feed water analysis by experienced specialists.

Unless a Boiler Compound has the right proportion of the right elements (and nothing else) to neutralize the harmful effects of the impurities, it is worthless, and may even be harmful.

If you have used BIRD-ARCHER COMPOUNDS you know that they are always good and reliable. You know that they are exactly adapted to their work and have virtues not found in other compounds.

Don't risk your boilers and make trouble for yourself by trying some inferior substitute. Our guarantee is made without reservation. If BIRD-ARCHER COMPOUNDS used as we direct don't remove old and prevent new deposits of oil, grease and scale, if they do not prevent pitting, grooving and corrosion, and do this without the slightest injury to steel, iron, brass fittings or packings, without cutting the cylinder lubricants and without causing the boilers to prime and foam, we ask no pay.

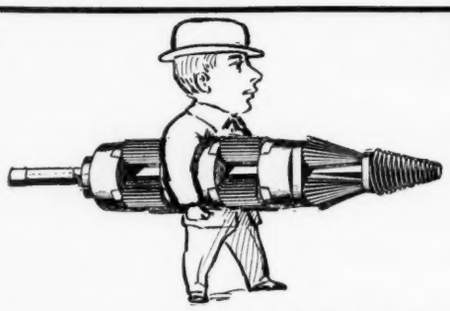
Write for our Book, "Ten Questions for Steam Boiler Users."

BIRD-ARCHER CO.,

90 WEST ST., NEW YORK CITY.

BRANCH OFFICES—Pittsburg, Pa., 506 Fulton Bldg. Boston, Mass., 7 Water St. Easton, Pa., 1st National Bank Bldg. Chicago, Ill., 501 Monadnock Blk. San Francisco, Cal., 24-26 Steuart St. Philadelphia, Pa., 56 North Delaware Ave. Baltimore, Md., 324 N. Holliday St. London, England, Billiter Bldg., E. C. Norfolk, Va., 22 Campbell's Wharf. New Orleans, La., 3215 Canal St. Cleveland, O., 403 Cleveland Arcade. Havana, Cuba, O'Reilly 67.

3



Boiler Tubes Cleaned While You Sleep

Don't stay up nights trying to get rid of that scale, and don't lose sleep worrying about how long the plant must be shut down, or about the dirt and mess.

Our experts come quicker than the fire department and with the Weinland Cleaner remove scale in less time, better, and for less money than your own men could. *Write for prices.*

This cut shows head for type of Cleaner driven by Air, Steam, Water or Electric Motor.

The LAGONDA MANUFACTURING COMPANY,

Manufacturers of Weinland Cleaners, Lagonda Automatic Cut-Off Valves, Reseating Machines, and Boiler Tube Cutters,

SPRINGFIELD, OHIO.

New York Boston Philadelphia Pittsburg Chicago Toledo St. Paul San Francisco

51-E

"CLEANLINESS IS NEXT TO IMPOSSIBLE" Unless You Use the Perfection Flue Cleaner

But the "Perfection" will clean all the scale from your tubes and leave them with a "smooth bore," The knives are self-sharpening and although they are death on scale they do not injure the tubes.

Ask for our Blue Book.

Scully Steel and Iron Company - - Chicago. Illinois.

PURE WATER FOR THE BOILERS BY THE

WE-FU-GO and SCAIFE

Water Softening and Purifying Systems.

RESULTS GUARANTEED SEND FOR OUR CATALOG.

WM. B. SCAIFE & SONS CO.,

Founded 1802. PITTSBURG, PA.

The A & D

Any size. Send for Circular.

Steam Flue Cleaner

Simple, Durable and Effective.

Cleveland Flue Cleaner Manufacturing Co., Power Blk., Cleveland, O.

ONLY DRY STEAM

gets out through the Sterling Exhaust Head. There's no falling drizzle to rot your roofs.

CATALOG?

ONLY PURE AIR

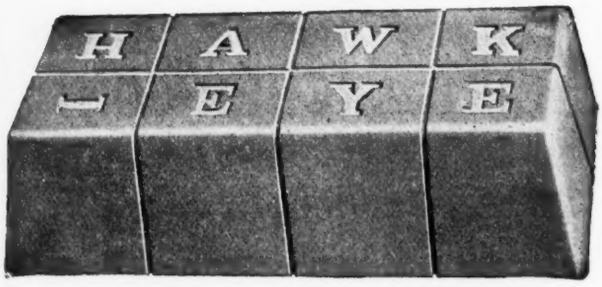
is breathed in buildings equipped with Sterling Ventilators. They are durable, effective, sightly.

STERLING BLOWER AND PIPE MFG. COMPANY, 6827 First Avenue, Hartford, Conn.

NEW YORK OFFICE, 109 LIBERTY STREET.

The Hawk-Eye Is The Only Boiler Compound Company

All other firms deal in other articles.



Eight one-pound squares in every block.
There is no acid in our compounds.

If a physician attempted to plead a law case in court he would be called a Jack of all trades and those who are engaged in all kinds of business and at the same time attempt to manufacture boiler compounds are Jacks of all trades and Masters of none.

After you have grown tired of spending money with that class, send us an order and you will not regret it.

Hawk-Eye Compound Company

303-304-305 Merrick Block, CHICAGO, ILL.

'PHONE WENTWORTH 135

Why! Is that the village where I vas last night! Last night? no, they tells me it vas twenty years ago. How it vas grown, everything vas so changed. But that

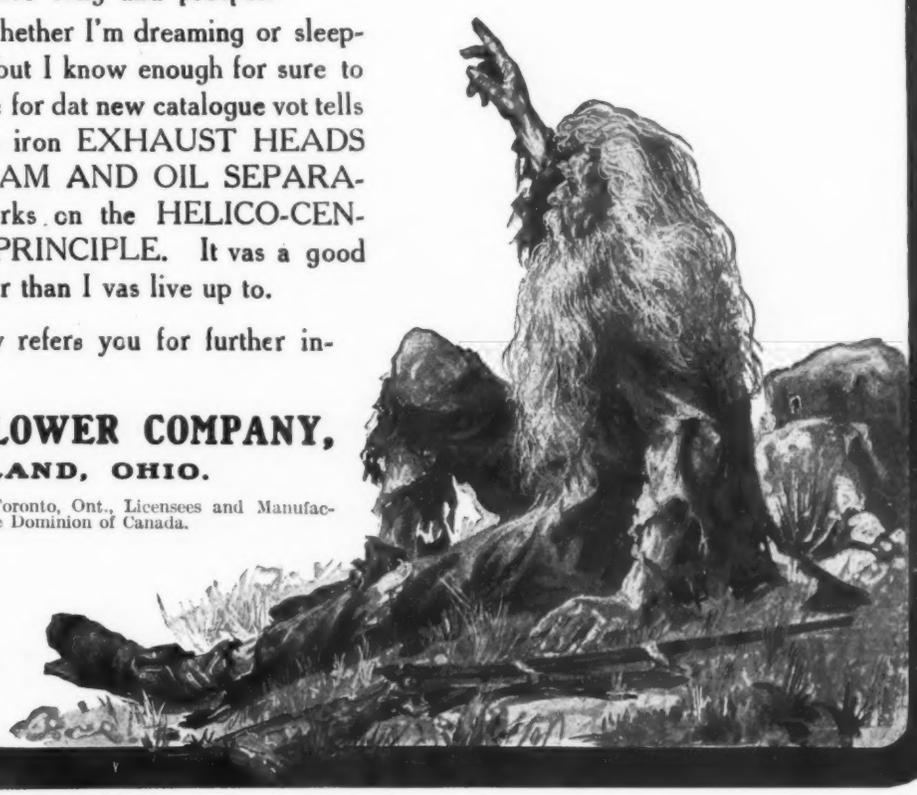
"SWARTWOUT"

CAST IRON EXHAUST HEAD

vas there just the same. How well I remember it. If Schneider vas here he would know it too.

I swore off you know, but we won't count this time; so here's to your good health and your family's and to everything that SWARTWOUT makes and may they live long and prosper.

I don't know whether I'm dreaming or sleeping or waking, but I know enough for sure to tell you to write for dat new catalogue vot tells about those cast iron EXHAUST HEADS and those STEAM AND OIL SEPARATORS dat works on the HELICO-CENTRIFUGAL PRINCIPLE. It vas a good principle—better than I vas live up to.



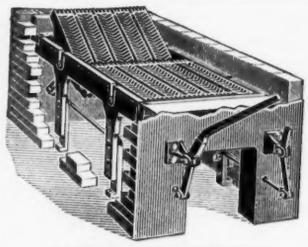
Rip respectfully refers you for further information to

THE OHIO BLOWER COMPANY,
CLEVELAND, OHIO.

Standard Engineering Co., Toronto, Ont., Licensees and Manufacturers for the Dominion of Canada.

Live Agents Wanted Everywhere.

1-41



SALAMANDER DUMPING GRATE.

ROGERS GRATE.

Any draft openings desired, from ¼ inch up. Made for both square and round furnaces. Commends itself on sight. Perfect combustion—long life—low price.

A GRATE QUARTETTE

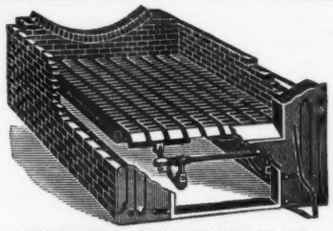
The Aetna Shaking Grate, Salamander Grate and Rogers Grate are a wonderfully efficient trio of coal savers. They are adapted to different conditions and each one gets highest quality results in its field. Let us tell you about the style you need.

Ask for our Book of Grates.

SALAMANDER GRATE BAR CO.

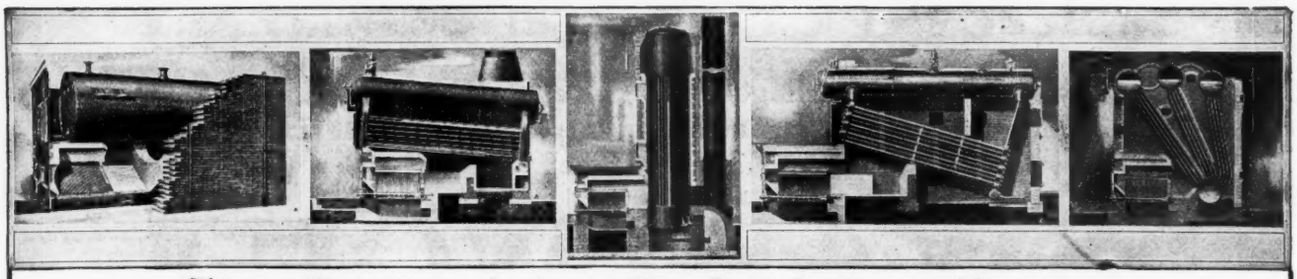
Telephone, 4136 Cortlandt.

126 LIBERTY ST., NEW YORK.



THE ORIGINAL ÆTNA SHAKING GRATE. 60 per cent. Air Space.

INTERLOCKING GRATE BAR. Old Reliable. Used in more than 10,000 Furnaces.



Any type of boiler.

The Murphy Automatic Smokeless Furnace

burns slack and other low cost fuels with unexcelled economy and absolute smokelessness. Strictly automatic in feeding and distribution of coal and the removal of the ash. Send for a complete description.

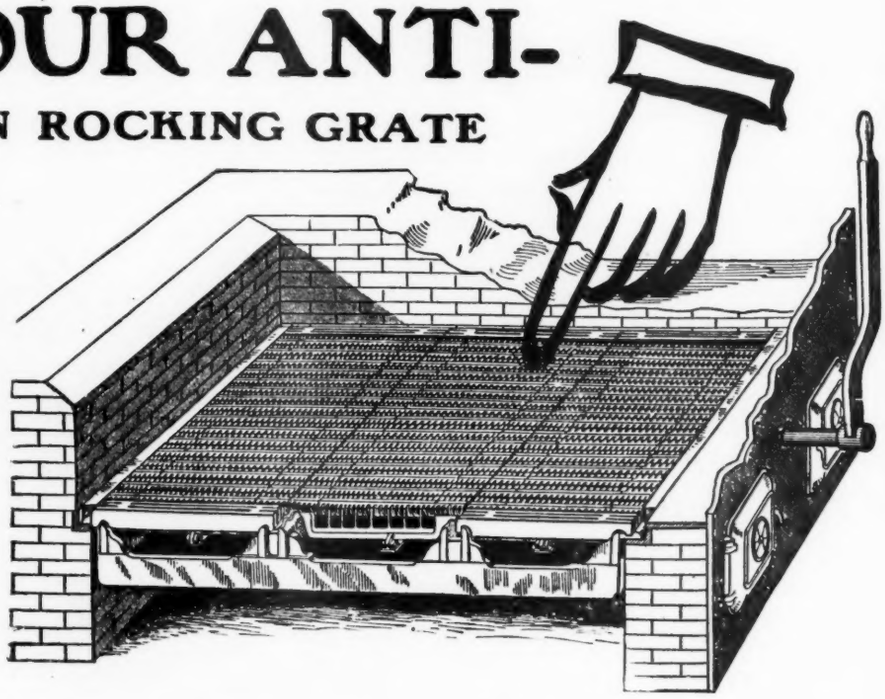
Murphy Iron Works, 5 Walker Street, Detroit, Mich.

Units of any size.

IT'S OUR ANTI-

FRICTION ROCKING GRATE

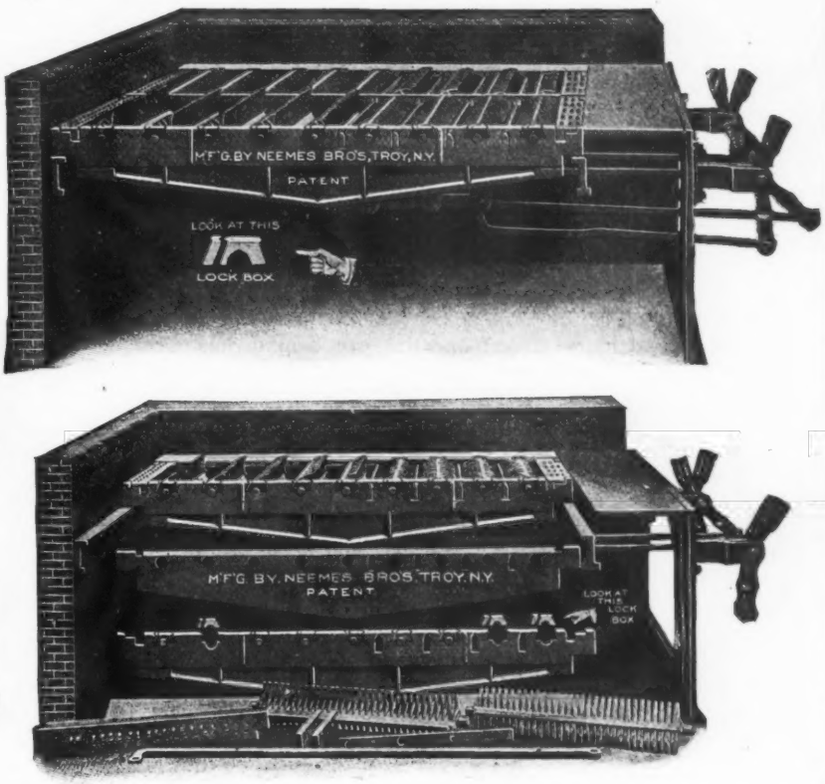
that makes the biggest possible savings in the power plant. It burns any old fuel perfectly and gets as good results as can be obtained from high priced coal. The Martin Grate can be installed in any furnace without altering the fire-box. Ask for catalog and list of users.



THE MARTIN GRATE COMPANY,

281 Dearborn Street, - - - Chicago, Ill.

NO OTHER GRATE



HAS THE CLINKER CUTTING SHAKING and DUMPING FEATURE

No matter what claims other grates may make, remember that the NEEMES BROS' IMPROVED GRATE, Shear Cutting Shaking Grate Front and Shaking and Dumping Grate Back is the ONLY ONE that will cut from both sides of the shaker alike. And remember this too—a slight agitation of the lever will shake out the *ashes only* (no unburned fuel can drop through), while if given a *full* opening, and shaken a few times, EVERYTHING is dumped into the ash pit. With the Neemes Bros' Grate you can burn a cheaper grade of fuel—and burn it ALL. Thus the cost of operating your plant will be materially reduced. *Write at once for full particulars.*

NEEMES BROTHERS,

41-49 Adams Street
TROY, NEW YORK, U.S.A.

MANUFACTURERS OF SQUARE AND ROUND GRATES

C. W. Van Blarcom, 126 Liberty St., Agent for New York City and vicinity. Babcock & Wilcox, Ltd., Montreal, Canada, Sole Makers for Canada. Burke Engineering Co., 311 Industrial Building, Providence, R. I., Sole Agents for the New England States. Cass Harkins, Hayden Building, Columbus, Ohio.

Westinghouse

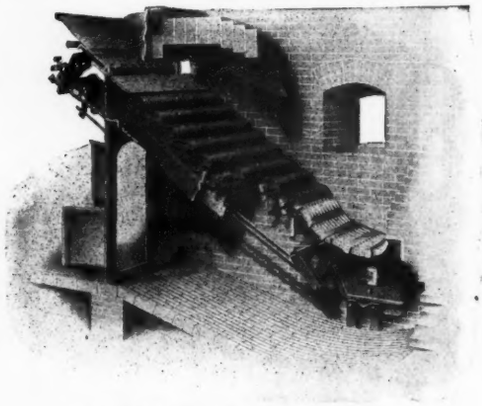
NEW MODEL RONEY STOKER

Retains all the fundamental principles of the older type, yet embodies a number of detail improvements, resulting in greater durability and more perfect and uniform combustion. Among the more important of these improvements are:

Number of grate bars reduced one-half.

Cooling surface of grates increased so that each pound of iron exposed to heat has 22 square inches of cooling surface exposed to cold air.

Improved application of pre-heated air to top of fire insures smokeless combustion.



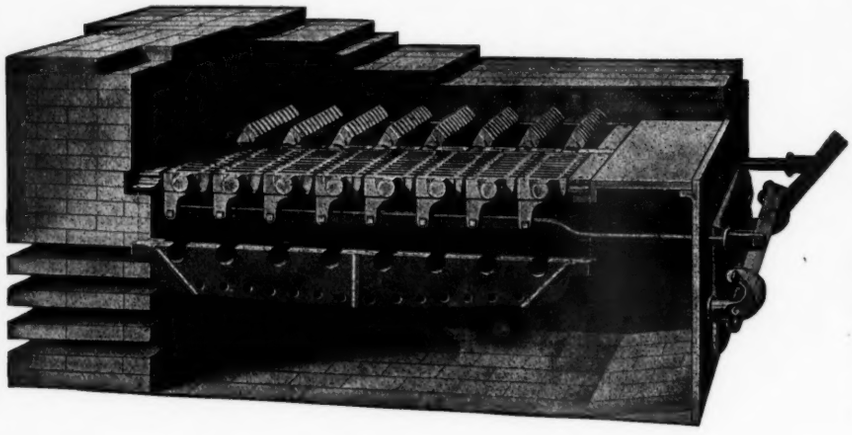
New Model Roney Stoker in Perspective

Our nearest office will give full particulars

The Westinghouse Machine Company,

Steam Turbines, Steam Engines, Gas Engines, Gas Producers, Storage Batteries and the Roney Stoker

New York, 165 Broadway.
Boston, 131 State Street.
Cleveland, New England Building.
Atlanta, Candler Building.
Chicago, 171 La Salle Street.
Cincinnati, Traction Building.
St Louis, Chemical Building.
Pittsburg, Westinghouse Building.
Philadelphia, North American Bldg.
Denver, 512 McPhee Building.
San Francisco, Hunt, Mirk & Co.



You Won't Be Roasted When You Dump

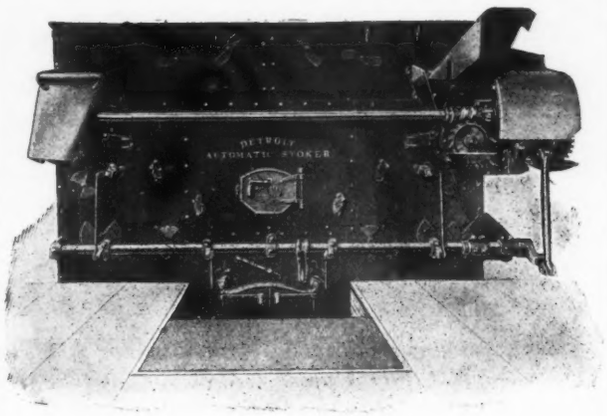
if your hands and face are protected by the closed door of

The Kelly Rocking and Dumping Grate

This grate dumps in sections cleaning one-half the fire at a time without opening the door. Thus the boiler is not subjected to the sudden shock of cold air. It burns all fuels and gets highest grade results in every case. Greater economy is bound to follow a "Kelly" installation. *Write for Grate Book K.*

Kelly Foundry & Machine Co., 603 9th Street, Goshen, Ind.

BOILER FRONTS, BOILER CASTINGS, STATIONARY GRATES, ROCKING AND DUMPING GRATES, ETC.



"The most economical method for Burning fuel in Power Plants."

Detroit Automatic Stoker

It burns all kinds of coal economically, reducing the fuel bill 10 to 25%.

It adds to the steaming capacity without injury to the boiler shell or tubes.

It feeds and burns the coal and cleans the fires with closed doors.

It insures uniform furnace temperature by continuous, positive feed for fuel.

It does all this with a SMOKELESS STACK.

Send for Catalog.

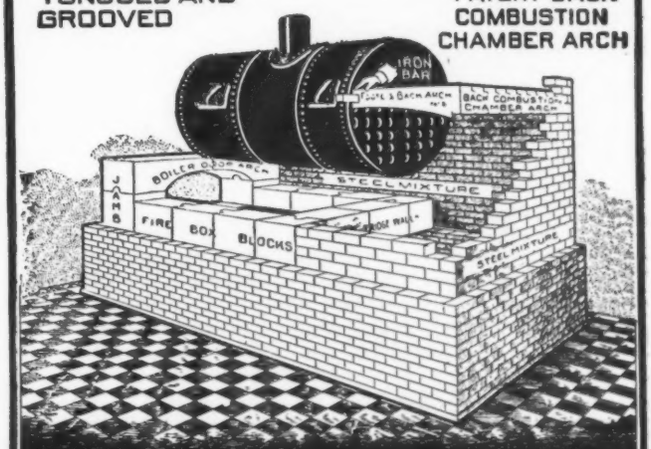
DETROIT STOKER & FOUNDRY CO.
DETROIT, MICH.

"STEEL MIXTURE"

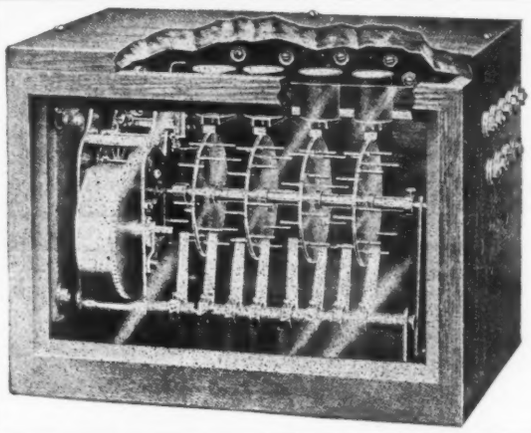
BOILER DOOR ARCHES AND FIRE BOX BLOCKS

TONGUED AND GROOVED

PATENT BACK COMBUSTION CHAMBER ARCH



MANUFACTURED BY
McLEOD & HENRY CO.
TROY, N.Y., U.S.A.
BRANCH OFFICE, 1402 BROADWAY, NEW YORK CITY.

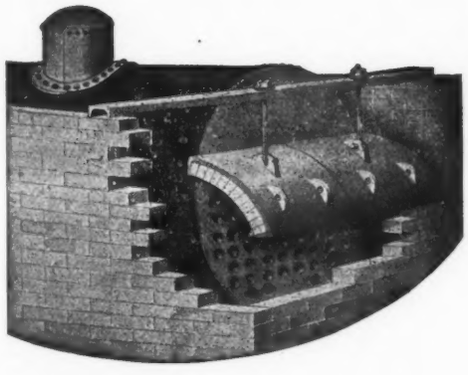


Smoke Prevention

Our new device economically solves the "Smoke Nuisance Problem." It prevents the formation of smoke in the furnace of a boiler by automatically regulating the air supply. The mechanism is very simple and positive. The novel timing arrangement controls the apparatus and operates independent of the fireman.

Write for Particulars.

Climax Smoke Preventer Co.,
205 Equitable Bldg., Boston, Mass.



IF YOU DON'T LIKE IT, SEND IT BACK

We'll ship you a **Monarch Boiler Arch** on these terms.

It consists of a metallic backing faced with fire brick. Hangs down from above and permits ready access to the boiler. One user writes us that before putting in our arches, he kept a mason at work putting up arches and rear settings nearly half the time. Now he makes no repairs whatever to either arches or settings.

Write for Booklet.

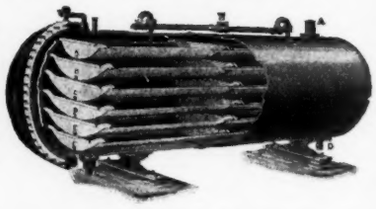
MAYVILLE SPECIALTY MFG. CO.,
MAYVILLE, WIS.

HOPPES EXHAUST STEAM FEED-WATER HEATERS

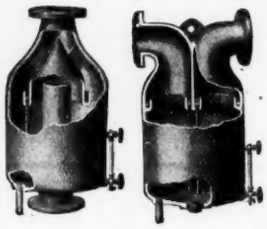
have a large heating and lime-catching surface and bring the steam and water together in a manner giving the highest efficiency both in the heating and purifying of the feed-water. Built in both steel and cast iron construction to suit conditions and requirements.

HOPPES LIVE STEAM FEED WATER PURIFIERS

keep boilers clean without the expense of chemicals. Write for particulars. Feed-water analyzed free for prospective customers. Send one quart by express, *prepaid*



HOPPES STEAM SEPARATORS



deliver 99% or better dry steam to the engine without wire-drawing. Cast iron construction, vertical and horizontal types, sizes 1½ to 9″ inclusive. Steel shell construction in all types and sizes.

HOPPES OIL ELIMINATORS

so thoroughly remove the oil from the exhaust steam that the condensate may readily be used for boiler feed or similar purposes. No baffle plates or tortuous passages to cause back pressure. Built in all sizes.

HOPPES CAST IRON EXHAUST HEADS

give the most efficient results, are attractive in appearance and *will not rust out* but last a lifetime. Prices right.

WRITE FOR CATALOG

Hoppes Manufacturing Co.

19 Larch St., Springfield, Ohio

Green Traveling Link Grates

Are Smokeless and Labor Saving.

They operate automatically during all the progressive stages of feeding the coal into the furnace, lighting and coking it. With their use everything combustible is consumed and all refuse is discharged into the ash pit.
Get some particulars now—it will pay you to.

Over 700,000 Horse Power in use.

MANUFACTURED BY

GREEN ENGINEERING COMPANY,

Commercial National Bank Building, Chicago, Ill.

GENERAL FOUNDRY WORK A SPECIALTY.

PERFECT COMBUSTION PRODUCES NO SMOKE

The Wilkinson Automatic Stoker And Smoke Preventer

procures perfect combustion and a consequent saving of 15% in fuel costs, to say nothing of saving the stokers wages.

WRITE FOR A CATALOG.

The Wilkinson Manufacturing Co.

Bridgeport, Montgomery County, Pa.

CONTRACTORS.
CENTRAL STATION HEATING.

Write for valuable information.

AMERICAN DISTRICT STEAM CO.,

Lockport, N. Y. Toronto, Can. Chicago.

COES IMPROVED COMBUSTION AND DRAFT SYSTEM

GEO. H. THACHER & CO.,

ALBANY, N. Y.

GRATES OF ALL KINDS. BOILER CASTINGS.

Over 7500 Hammel Oil Burners

In use under Stationary Boilers, Locomotives, Kilns, Etc.

Write for Circular of Hammel Patent Furnace for Water-Tube Boilers

HAMMEL OIL BURNER CO.

609 North Main Street, LOS ANGELES, CAL.

ELEPHANT BRAND

DELTA

REG. U. S. PAT. OFF.

THE PHOSPHOR BRONZE SMELTING CO., Limited.

2200 WASHINGTON AVENUE, PHILADELPHIA, PA.

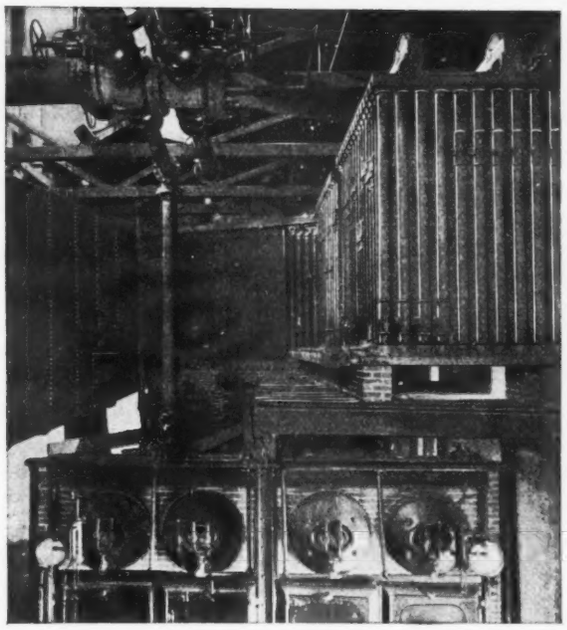
ELEPHANT BRAND "Phosphor Bronze"

INGOTS, CASTINGS, WIRE, RODS, SHEETS, Etc.

— DELTA METAL —

CASTINGS, STAMPINGS AND FORGINGS

ORIGINAL AND SOLE MAKERS IN THE U. S.



HIGH RENTAL FOR BOILER ROOM SPACE

You can get a high rental for any spare room in your power house by utilizing it for an installation of Green Fuel Economizers. The Economizer can be placed almost anywhere back of, above or below the boilers. It will make a return of from 25% to 100% of its first cost yearly, which, after deducting 5% for interest charges and 5% to 10% for attendance and depreciation, leaves you a handsome rental upon the space occupied.

In most boiler plants no difficulty will be experienced in finding a place for the economizer, and where there is difficulty we can solve the problem satisfactorily. *We* have put in Economizers in connection with boilers representing over 50,000,000 H. P., for heating water for boiler-feed and for washing, dyeing, paper making, salt manufacture, heating buildings, etc. The Economizer recovers heat that otherwise goes to waste from boiler furnaces, metallurgical furnaces, coal-gas retorts, water gas machines, oil stills, crucible furnaces and other processes that waste hot gases to the atmosphere.

If you will send us a sketch showing your lay-out and a statement of your conditions we will make suggestions as to what can be done, and the possible savings. We are pleased to give this information whether you decide to purchase or not, as the diffusion of knowledge about so profitable a piece of apparatus as the Green Economizer ultimately leads to its adoption.

Ask for our new treatise, "106 P," on "The Economizer and It Uses."

THE GREEN FUEL ECONOMIZER CO.
MATTEAWAN, N. Y.

New York City, Boston, Chicago, Atlanta, San Francisco, Los Angeles, Seattle, Salt Lake City, Montreal.

Engineers; Builders of Green's Fuel Economizers, Fans, Blowers and Exhausters, Steam Air Heater Coils, Waste Heat Air Heaters, Mechanical Draft, Heating and Ventilating and Drying Apparatus, Draft Dampers and Engines. 179

"Horse Sense" Applied To Feed Water Heating

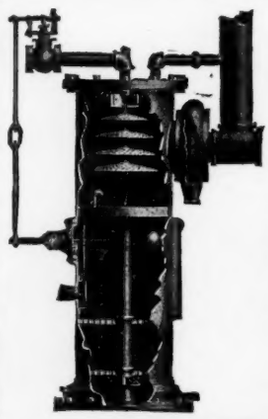
The National

Feed Water Heater consists simply of from one to fourteen coils of seamless-drawn brass or copper tubing incased in a cast iron or steel shell, to which exhaust steam is admitted, heating the water which passes through the coils. Nothing could be simpler, more effective or more economical. Get the full details.

Want the Catalog?

The National Pipe Bending Co.
168 River St., New Haven, Conn.

120 Liberty St. New York
54 High St. Boston, Mass.



OUR TWINS

EITHER ONE WILL SAVE

15% of fuel and preserve the boiler.

Write for Prices, Etc.

The Sims Co.,

ERIE, PA.

Branch Office:
136 Liberty St., New York,
Tel., 539 Cortlandt.

THE HOT WATER CURE

for your boilers will enable you to get the greatest possible profit from your steam, provided you install the

Patterson-Berryman Feed Water Heater

It removes scale forming impurities from the feed water and heats the water almost to the boiling point. Suppose you borrow one for 60 days.

WRITE!

Frank L. Patterson & Co.
28 Cortlandt Street, New York, U.S.A.

The Reilly Multicoil Feed Water Heater

High Efficiency on account of long travel of water through the coils; thorough agitation of water, therefore rapid absorption of heater; the scouring of the inside of tube walls caused by the centrifugal force of the flow **prevents scale accumulation** in the coils.

Every coil a spring, no temperature strains.

All tubes secured to headers with ground union joints.

Accessibility to interior parts through large door in the shell, without disconnecting pipes.

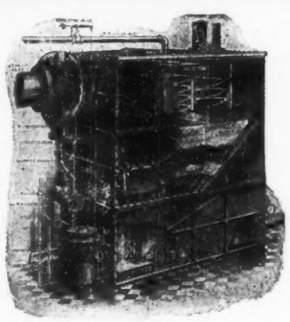
Tubes all standard and may be replaced by the engineer using no other tool than a wrench.

Sizes: 30 H. P. to 6000 H. P.

Write for Catalog.

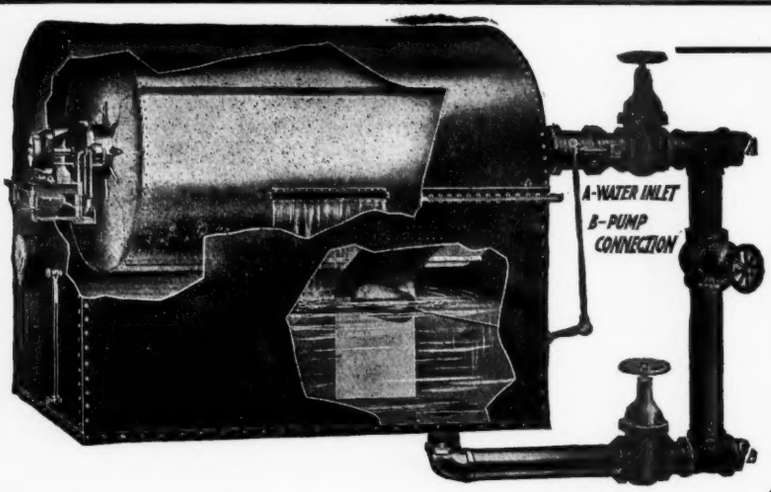
THE GRISCOM SPENCER COMPANY
General Offices: 90 WEST ST., NEW YORK.

The Marion System Heats, Treats And Filters Feed Water.



It combines in one apparatus an OIL SEPARATOR, HEATER, REAGENT SYSTEM and FILTER. Extracts all impurities from the water and removes oil from the exhaust. Saves 15% in water, and 15% in fuel, thus *paying for itself* in short order. It is better than any other device or system—ask the power user who has one in his plant. Catalog **G-11** goes into details.

THE MARION INCLINE FILTER AND HEATRE CO. MARION, OHIO.



What Are Your Boilers Doing?

Are you getting the best economy?
Is your coal best fitted for your purpose?
Can You Tell Your Evaporation?
A

DETROIT METER

Will Give You a Continuous Record of Your Boiler Feed Water

Built in all sizes for all requirements of power plants, heating companies and for measuring any liquid.

CENTRAL STATION STEAM COMPANY
Detroit, Mich., U. S. A.
SEND FOR CATALOG.

GUARANTEED TO

heat the feed water to 210-212° F.

To permit easier cleaning than any other tubular heater.

To extract the oil from the exhaust and also to carry off the water of condensation.

To retain its heating qualities long after other heaters have become useless.

We guarantee this—and much *more* besides for the Otis Tubular Feed Water Heater and Purifier.

Write for full information.

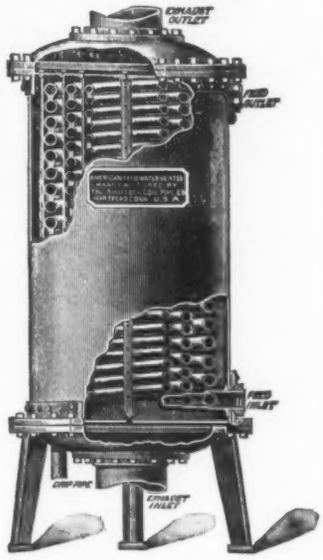
THE STEWART HEATER CO.
50 Norfolk Avenue, Buffalo, N. Y.

The American Standard Copper Coil Feed-Water Heater

represents the highest type of feed-water heating apparatus and should always be used where the highest temperature and most satisfactory results are desired.

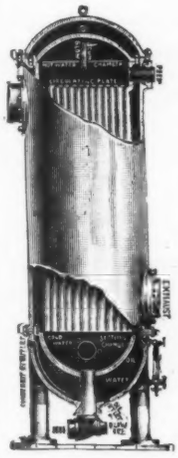
It costs no more than less efficient types.

It is the simplest and most widely used type of heater in the market today.



Manufactured by
The Whitlock Coil Pipe Company
Hartford, Conn.
New York Office, Singer Bldg., 85 Liberty St.

SIMPLE, QUICK AND EASY TO CLEAN



You don't have to remove any of the piping. Just take off the two top caps and the circulating plate, run a scraper through the tubes, and remove the scale from the lower water chamber through the hand holes.

THE RIBLET FEED-WATER HEATER

guarantees the highest efficiency. It not only reduces fuel bills, but furnishes hot water so near the temperature of steam that the boiler is not strained by the sudden shock of cold feed water. *Write today for a Catalog.*

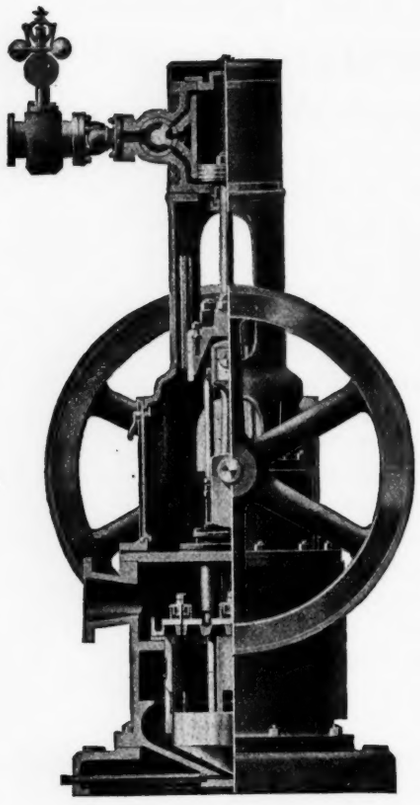
ERIE MFG. & SUPPLY CO.,
1203 PEACH ST., ERIE, PA.

RADIATION CONQUERED

One of the drawbacks common to ordinary Feed Water Heaters is the loss of heat by *radiation.*

In the Baragwanath Steam Jacket Feed Water Heater, this loss is prevented by providing for a wall of steam between the inner shell and the jacket. Thus the water is heated to a higher temperature and kept there without loss. The *principle* is obviously correct. Catalog explains more fully.

Wm. Baragwanath & Son
54 West Division St.
Chicago, Illinois, U. S. A.
Thos. B. Whitted, Piedmont Bldg., Charlotte, N. C., Southeastern Manager



THE WHEELER-EDWARDS SUCTION-VALVELESS AIR PUMP

This pump has no foot or bucket valves, but the pump chamber is in perfectly free communication with the Condenser during the admission period, so that the entire difference in pressure between the pump and condenser acts to deliver air and vapor to the pump, no part of the pressure being required to raise valves or water on top of valves. The pump cylinder is therefore filled with air and vapor at full condenser pressure. Further, the water of condensation, is driven into the pump chamber by impact and serves to draw in more air and vapor just as the plunger closes the admission ports on its return stroke.

At the end of the stroke, the clearance for air is reduced to zero by the fact that the air and gases are driven out ahead of the water brought up by the plunger.

The highest vacuums required for steam turbine work are easily obtained by the Edwards Pump without the use of rotative dry vacuum pumps, air coolers, separate condensation pumps, and other expensive complications. We have plants in operation where close to absolute vacuum is obtained regularly. The Edwards Pump gives you the opportunity to obtain high vacuum at a moderate cost.

Kindly submit your plans to us, and we will be pleased to supply lay-out and estimate. We build single, duplex, and triplex pumps, steam driven, belt driven, and electrically driven, or attached to the tail rod or cross head.

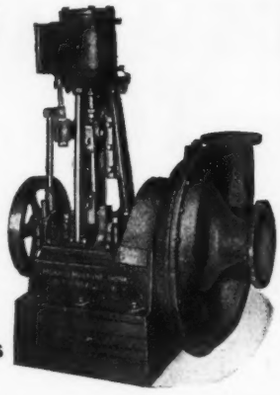
Ask for "Bulletin 3 P."

Wheeler Condenser and Engineering Company,

West Street Bldg., New York. Works, Carteret, N. J.

CENTRIFUGAL PUMPING MACHINERY

Built with a knowledge gained in 40 years of successful pump building, we make these pumps for every possible service.



Morris Machine Works
Baldwinsville, N.Y., U S.A.

Prescott Condensing Apparatus

Complete Line for Power Plants.

Boiler Feed and General Service Pumps for all conditions.

Send for Catalogue 20-H.

FRED. M. PRESCOTT STEAM PUMP CO.,
MILWAUKEE, WIS. 45

STEAM PUMPS

QUALITY AND PRICES ARE RIGHT.

BLAKE PUMP & CONDENSER CO.,
FITCHBURG, MASS.
☞ YOUR LOSS IF YOU DON'T KNOW US.

Puts Scale Out Of Business

before it ever reaches the boiler tubes by delivering only clear, clean feed water.

Circular No. 30 on request.

F. E. Keyes & Son, 20 Broad St., New York.

The BARNES Positive Feed DRILLS

8 to 50' Swing

Our positive Feed means 15 to 25 per cent. increase in output of work.

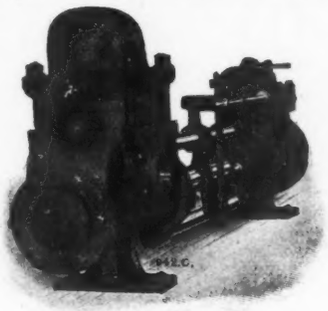
Send for Catalog.

W. F. & John Barnes Co.,
990 RUBY STREET,
Rockford, Illinois.

TRADE MARK

DEAN BROTHERS STEAM PUMP WORKS

INDIANAPOLIS, IND.

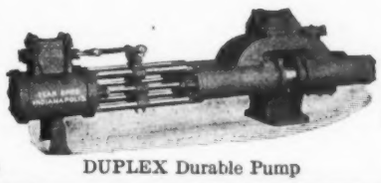


SIMPLE Boiler Feeder

JET AND SURFACE CONDENSERS

DUPLEX and SIMPLE Steam Pumps

Boiler Feeders
Fire Pumps
Electric Pumps
Vacuum Pumps
Deep Well Power Pumps



DUPLEX Durable Pump

Fly Wheel Pumps
Distillers' Pumps
Plunger Pumps
Ballast Pumps
Atlantic Type Pumps

Vertical Air Pump and Jet Condenser

IN STOCK FOR PROMPT SHIPMENT.

BOILERS.

4 72″x18′, 125 lbs. pres., "Wickes," NEW.
4 72″x16′, 125 lbs. pres., "Wickes," NEW.
1 300 H.P. "Wickes" vertical water tube.
3 200 H.P. "Geary" water tube.
1 150 H. P. "Wickes" horizontal water tube.
500 H.P. "Seabury" marine boiler.
100 H.P. "Economic" portable boiler.

ENGINES.

2 38″x72″ modern heavy duty, "Corliss," practically NEW.
30″x72″ R. H. "Corliss."
30″x60″ "Rankin & Fritsch" Corliss.
28″x60″ "Harris" Corliss. 23″x60″ "Corliss."
19″ and 38″x48″ "Allis" Corliss.
28″x56″ L. H. "Buckeye" automatic.
15″x17″ automatic vertical.

AIR COMPRESSORS.

18½″x11¼″x4″ "Ingersoll-Sergeant."
18″x18″x18″ "Laidlaw-Dunn-Gordon."
16″x15″x16″ "Straight Line."
16″x10″x10″ "Blaisdell," Class A. C.
12″x16″x14″ "Hall" Straight line.
11″ and 6″x6″ "Pedrick & Ayer," No. 1.
10″x18″x18″ "Snider-Hughes."
10″x10¼″x7½″x12″ D'Auria, duplex comp.

CONDENSERS.

1400 H.P. "Wheeler" surface condenser, with combined vacuum and circulating pump, two 12″ exhaust inlets.

DUPLEX PUMPS.

20″x8″x16″ "Canton," 6″ dis.
17″x7½″x15″ "Worthington," 4″ dis.
16″x12″x10″ "Smith-Vaile," 7″ dis.
14″ and 20″x12″x12″ comp., 10″ dis.
14″x14″x18″ "Hughes," 10″ dis.
12″x7″x10″ "Worthington," 4″ dis.
10″x6 x14″ "Smith-Vaile," 4″ dis.
10″x6″x10″ "Canton," 4″ dis., NEW.
6″x4″x6″ "Smith-Vaile," 2″ dis.

GENERATORS, DIRECT CONNECTED TO ENGINES.

50 K.W., 110 Volt, 1000 light, Gen Elec., direct connected to 10″ and 14″x14″ "Russell" tandem comp, automatic engine.
50 K.W., 125 Volt, 1000 light, Commercial direct connected to 11″x14″ Buckeye style C., automatic engine.
16 K.W., 80 Volts, Gen. Elec. generator, direct connected to 8½″x6″ double, vertical automatic engine.
15 K.W., 125 Volts, 300 light, Westinghouse direct connected to 7½″x10″ L. H. auto. engine.

DIRECT CURRENT GENERATORS.

100 K.W., 250 V., 2000 Lt., "Milwaukee."
80 K.W., 125 V., 1600 Lt., "Westinghouse."
40 K.W., 125 V., 800 Lt., "Detroit" bipolar.
30 K.W., 220 V., "Fort Wayne."
27½ K.W., 110 Volt, 550 Lt., four-pole.
16½ K.W., 110 V., 3330 Lt., "Rockford."
10K.W., 110 V., 200 Lt., "Thompson."
100 H.P., 500 Volt., "Westinghouse," D.C. Motor.

Send for monthly stock lists of refitted machinery and power equipment. Prompt shipment of all items listed.

WICKES BROTHERS, Saginaw, Mich. New York. Pittsburg.

Do you want a high duty air pump that won't stop? Made in two styles—single, for engine work—two stage, for turbine work.

The air pump is operated by a Corliss engine with variable speed control. Engine and air pump both accessible for cleaning and adjustment without taking down.

New Corliss Engines for Immediate Delivery		Corliss Engines for 30 Days Delivery	
1 10x24,	50 H. P.	3 10x24,	50 H. P.
2 12x36,	75 "	1 12x30,	75 "
1 14x36,	115 "	2 14x36,	100 "
1 16x36,	136 "	1 16x30,	125 "
1 16x36,	150 "	1 16x36,	150 "
1 16x42,	200 "	1 18x36,	190 "

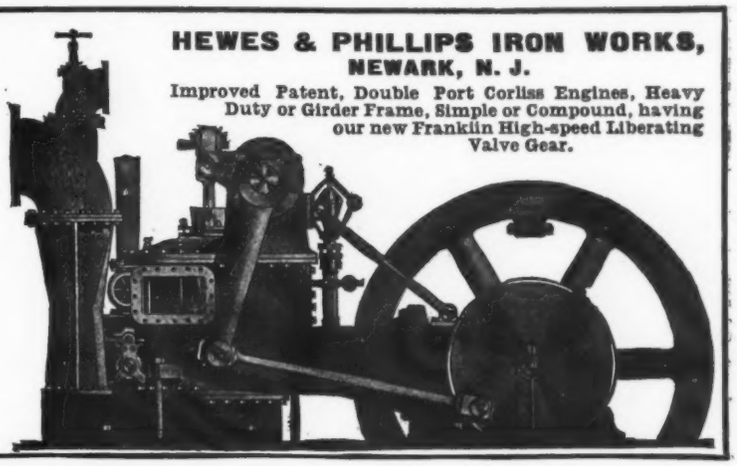
One 500 H. P. Tandem Compound Corliss Engine. New. Cylinder 16x30x36.

Second-hand Engines.

One 16x36 Corliss Engine, 150 H.P., capacity, in first class order, for immediate delivery.
One 12x36 Corliss Engine, 75 H. P., in first class order, for immediate delivery.

HEWES & PHILLIPS IRON WORKS, NEWARK, N. J.

Improved Patent, Double Port Corliss Engines, Heavy Duty or Girder Frame, Simple or Compound, having our new Franklin High-speed Liberating Valve Gear.



MYERS POWER PUMPS.

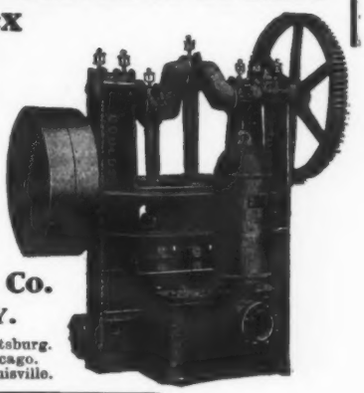
Adapted especially for gas engines, motor and belt powers, in harmony with present requirements. Catalog sent on request.

F. E. Myers & Bro.
Ashland, Ohio, U. S. A.

The Many Installations of GOULDS Efficient Triplex Power Pumps

For Municipal Water Works
Boiler Feeding
Hydraulic Elevators
Mine Pumping
General Water Supply, Etc.

Have fully demonstrated their practicability and efficiency for these important services.

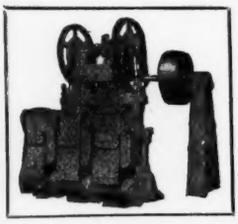


The Goulds Mfg. Co.
Seneca Falls, N. Y.

New York. Philadelphia. Pittsburg.
St. Louis. New Orleans. Chicago.
Los Angeles. San Francisco. Louisville.

Deming

Ask for Catalogue "G" and treatise "Feeding Boilers."



For any service. **Power**

For operation by any power. **Pumps**

The Deming Company

Agencies in Principal Cities

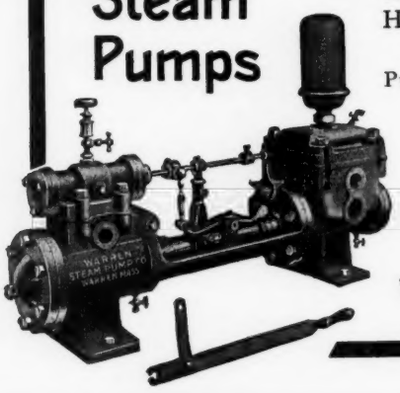
Salem, Ohio

Steam Pumps

of the Highest Class.

Repairing of Pumps a specialty.

Send for Catalog.



Warren Steam Pump Co.,

Warren, Mass., U. S. A.

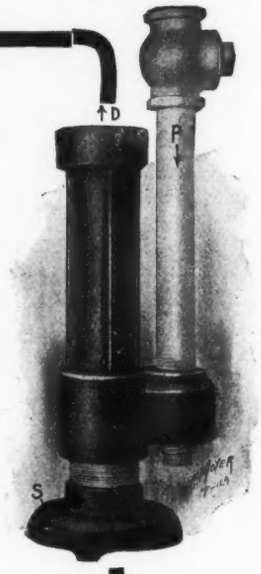
KOERTING CESSPOOL PUMP

IS a very satisfactory apparatus for elevating any liquid containing solid matter, such for instance as is come in contact with in Sewer and Street Construction; and for cleaning out sumps and cesspools; also in establishments where dirty dish-water, refuse from ice cream parlors, etc., drain into a well or pit.

For such purpose the opening through machine is made fully large, and a strainer is provided with ample openings in proportion.

This Evacuator is used for various purposes of like nature.

It is operated by steam pressure through an annular nozzle, the opening of which is necessarily small; and to prevent the scale or particles lodging therein, the steam pipe is also provided with a strainer.



Write for Catalog 2-A.

SCHUTTE & KOERTING CO.

12th & Tompson Sts., Philadelphia.

NEW YORK: 50 Church St. CHICAGO: Security Bldg.
BOSTON: 43 High St. PITTSBURG: Keenan Bldg.

COOLING TOWERS

Fan—and Natural Draft

GEORGE J. STOCKER

2833 S. KINGS HIGHWAY BOUL., ST. LOUIS, MO.

WRITE FOR CATALOG

Guaranteed to form the best Vacuum by head of water or by supply pump

***The* Bulkley Injector Condenser**

In general use on all classes of engines.

New York Office: 141 Broadway.

Henry W. Bulkley, ENGINEER, Orange, N. J., U. S. A.

INSIST ON GARDNER PUMP GOVERNORS.

If a dealer tries to palm off a "just-as-good" on you, remember that it is bound to lack the genuine Gardner **quality.** The general outlines may be somewhat similar, but in *operation* the substitute falls short of the Gardner mark. Catalog describes in full.

The Gardner Governor and Separator Company,

QUINCY, - - ILLINOIS.

Alberger

Condensers

Surface
Centrifugal
Barometric

Wainwright

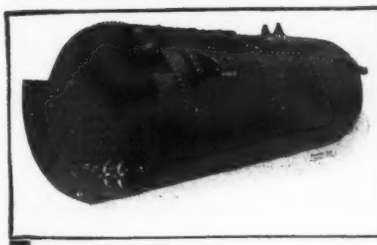
Heaters
Generators
Expansion Joints

Alberger Condenser Company

95 Liberty Street, New York

Branch Office: 205 LaSalle St., Chicago.

Reeves & Skinner Machinery Co. 617 Chemical Bldg., St. Louis.



KEWANEE BOILERS
Are Boilers of CHARACTER

They bear the mark of superiority. They are built by mechanics, are strong, solid, substantial, efficient, durable. Have the name KEWANEE in your specifications.

KEWANEE BOILER COMPANY
KEWANEE, ILLINOIS.

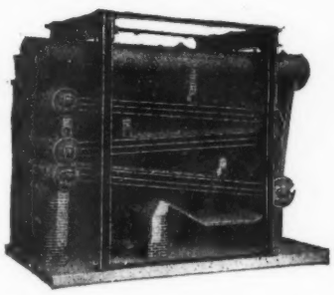
Rapid Circulation Prevents Scale

That's one way in which the

VOGT WATER TUBE BOILER

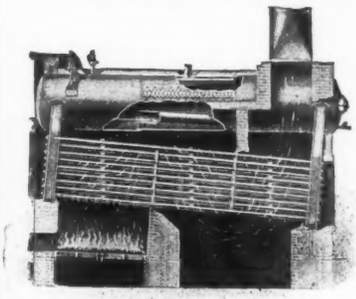
saves money for its owner—but there are many other ways—let us tell you.

Circular?



Henry Vogt Machine Co., Inc., Louisville, Ky.

Water Tube Boilers



All Wrought Steel Construction

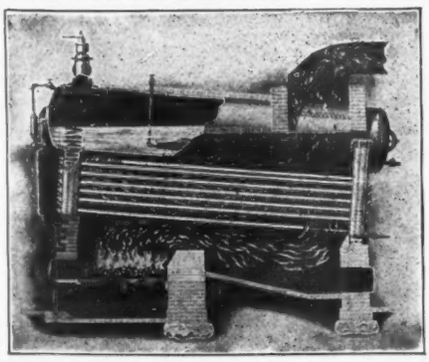
Ask for New Catalog P. W.

ESTABLISHED 1865.

E. KEELER CO.
Williamsport, Pa.

New York, Philadelphia, Chicago, San Francisco, Wilkesbarre and New Orleans.

FRANKLIN WATER TUBE BOILER



BUILT BY

FRANKLIN BOILER WORKS CO.,

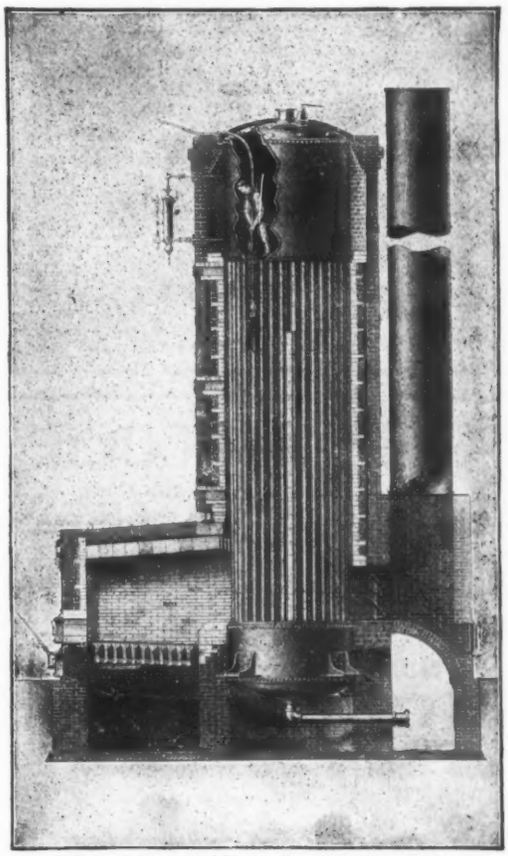
TROY, N.Y.

SALES OFFICE
39 Cortlandt St.,
New York, N. Y.

The Wickes Boiler

Vertical Water Tube

Ever cleaned a boiler? Know how hard it is? If you have you will appreciate this boiler at a glance.



Cut shows position of man cleaning; Is it laborious compared with usual forms?

Two 12″ x 16″ manholes open the Wickes Vertical Water Tube Safety Steam Boiler from top to bottom for inspection and cleaning. Every tube can be looked through; every tube washed or scraped.

Safe.
Low cost of maintenance.
High furnace and heat abstracting efficiency.
Absolutely dry steam.

Ask us for Bulletins—sent free.

The Wickes Boiler Co.

Main Office and Works:
Saginaw, Michigan

Sales Offices:
1411 West Street B'ld'g, West and Cedar Sts., New York City.
1139 American Trust Bl'd'g, Chicago, Ill.
Penobscot B'ld'g, Detroit, Mich. Empire Bl'd'g, Pittsburg, Pa.
601 Brown-Marx B'ld'g, Birmingham, Ala.

Parker Boiler Company,
Pennsylvania Building,
Philadelphia, Pa.

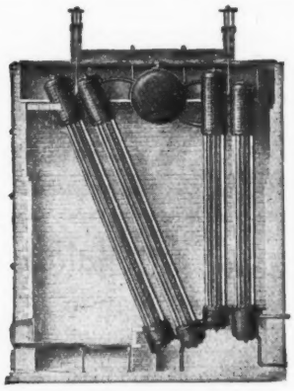
PARKER BOILERS

NEW YORK—
90 West Street.
PITTSBURG—
1806 Machesney Bldg.
CHICAGO—
1519 Marquette Building
DENVER—
1707 Glenarm Street.
SAN FRANCISCO—
Main and Folsom Sts.

The Bigelow-Hornsby Water Tube Boiler

UNLIMITED SIZE OF UNITS, 2,500 HORSE POWER OR MORE.
COLDEST WATER MEETS THE COLDEST GASES.
DIRECT HEATING SURFACE ABOUT FOUR TIMES AS GREAT AS THE AVERAGE WATER TUBE BOILER.
ALL PARTS, BOTH EXTERNAL AND INTERNAL, READILY ACCESSIBLE.
ALL BOILER TUBES PERFECTLY STRAIGHT.

Large well Illustrated Catalog on request.



ALL TYPES OF FIRE TUBE BOILERS.

Vulcanizers, dryers, foundry cupolas, tanks, stacks and special work.

THE BIGELOW COMPANY, NEW HAVEN, CONN.
New York Office, 85 Liberty St. Boston Office, 141 Milk St.

THE BABCOCK & WILCOX COMPANY

85 LIBERTY STREET, NEW YORK

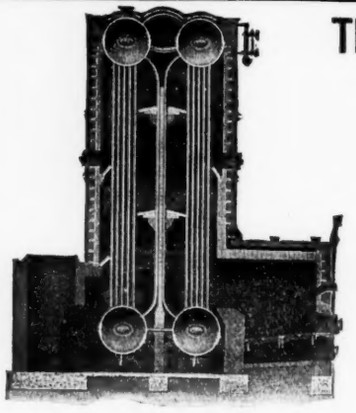
WATER TUBE STEAM BOILERS

STEAM SUPERHEATERS—MECHANICAL STOKERS

Barberton, Ohio — WORKS — Bayonne, N. J.

BRANCH OFFICES

Boston—Delta Building
Philadelphia—North American Building
San Francisco—99 First Street
Pittsburg—Farmers Deposit Nat. Bank Building
New Orleans—533 Baronne Street
Denver—435 Seventeenth Street
Salt Lake City—Atlas Block
Chicago—Marquette Building
Atlanta, Ga.—Candler Building
Cleveland—New England Building
Mexico City—7 Avenida Jurez
Havana, Cuba—116½ Calle de la Habana
Los Angeles—Trust Building
Cincinnati—Traction Building



Type B

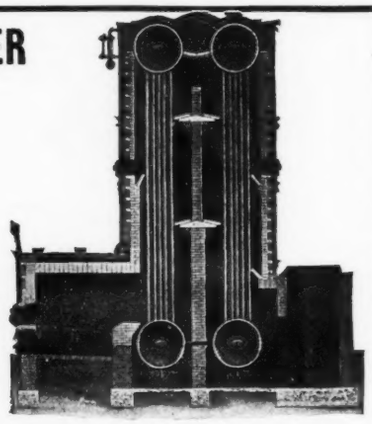
THE RUST WATER TUBE BOILER

Safe
Simple
Economical
Durable
Accessible

THE RUST BOILER COMPANY,
Pittsburgh, Pa.

THE RUST ENGINEERING CO.
BIRMINGHAM, ALA., and NEW ORLEANS, LA.
SOUTHERN AGENTS.

Write for Report of Tests by William Kent.



Type C

TUBULAR AND WATER TUBE TYPES

TUDOR BOILERS

INCORPORATED 1834

The Tudor Boiler Mfg. Co., - Cincinnati, Ohio

TANKS AND STEEL PLATE WORK

Foster Superheaters

Insure economical steam consumption on light loads.

POWER SPECIALTY CO.,
111 BROADWAY, NEW YORK.

The Copes Boiler Feed Regulator
automatically holds the water level at one point and feeds the water as needed. The Copes Pump Governor controls the feed line pressure. *Write for book "P."*

AMERICAN BOILER ECONOMY CO.,
Philadelphia Boston Baltimore

HEINE BOILERS
(Water Tube)

All flange steel construction.
Shipped from the shop completed.

BUILT ONLY BY THE

Heine Safety Boiler Co.
ST. LOUIS, MO.

Chas. C. Moore & Co., Engineers.
INCORPORATED

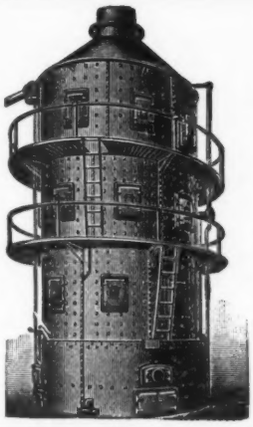
CONTRACTORS FOR COMPLETE PLANTS

Power Lighting | Pumping Mining

MACHINERY OF THE HIGHEST GRADE

Now located at our old Site
63 First Street, San Francisco

BRANCHES AT
Los Angeles, Cal., 321 Trust Bldg. Salt Lake, Utah, Atlas Block.
Seattle, Wash., Mutual Life Bldg. New York, Havemeyer Bldg.
CORRESPONDENCE SOLICITED



"Climax" is the Boiler to Install.

Why not have a boiler that will do its duty thoroughly? That is, a boiler that will get out of coal and water all the steam possible to get and hold its pressure under unfavorable conditions. That's the "Climax." It's the boiler of the present. Shall we send the Catalog?

The Morrin Climax Boiler Company, BROOKLYN, N. Y.

Main Office: 240 Lorraine Street. Works: Smith, Lorraine, Court & Creamer Streets.
Telephone, 243 Hamilton.

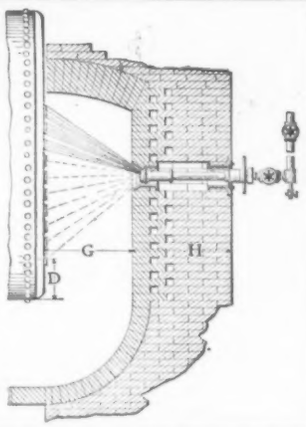
Do You Realize

what it means in the Economy of the Boiler Room to keep the boiler flues absolutely free from soot all the time? You can't do it by blowing the soot against the draft; this method defeats its own end. Use the

MONARCH STEAM FLUE BLOWER

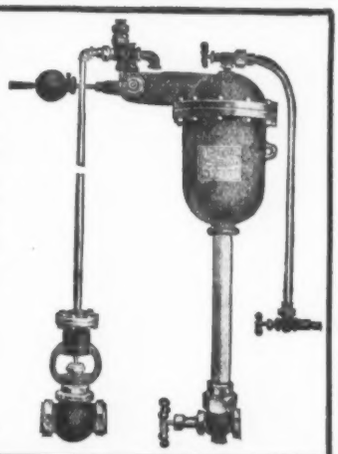
It blows with the draft without loss of steam pressure or time and IT SAVES FUEL. Circular?

Monarch Steam Blower Company, Troy, N. Y.



The Vigilant Feed Water Regulator

for Steam Boilers was the first in the field, and has the longest and best record of any of these devices. *Costs less to operate and maintain.* Constructed on a different and better principle than any other. Investigate it and the FULTON PUMP GOVERNOR, and send for latest catalog with list of users. A guarantee from a responsible firm with every machine.



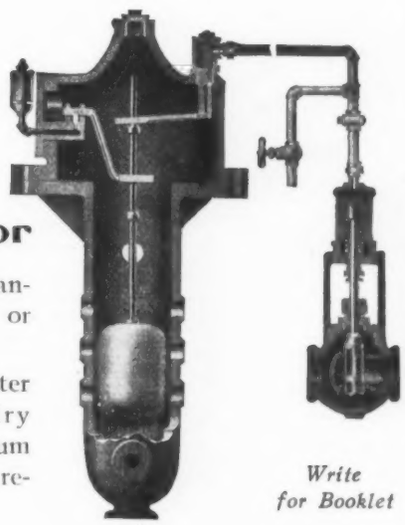
THE CHAPLIN-FULTON MFG. CO.,
PITTSBURG, - PA.
D. W. Patterson, Agent, Harrison Bld., Philadelphia, Pa.

We Guarantee

The Gould Feed Water Regulator

to obviate all danger from high or low water.

The perfect water level means dry steam at minimum cost and smaller repair bills.



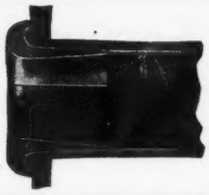
Write for Booklet

THE SAFETY EQUIPMENT MANUFACTURING CO.
Power Plant Specialists
176 E. Lake Street CHICAGO, ILL.

Saves Cost—Avoids Delay

A set of Cruise Tube Protectors will make new tubes of your old ones at a trifling cost. *Write.*

CRUISE & CO., 141-150 Broadway Elizabeth, N. J. Telephone Nos. 745R—526R



FOR SALE

One 50 H. P. Tandem Cylinder Gas Engine little used, at a bargain. Also 3 or 4—25, and 30 H. P. Gas Engines at a reduced price. Good as new.

Ajax Iron Works, Corry, Pa.

FOOS GAS ENGINES

Producer Gas Plants. Vertical Multiple Cylinder and Horizontal Engines. 2 to 500 H. P.

Suitable for all fuels for all power purposes. Speed regulation guaranteed within 2 per cent from no load to normal. The Foos is the result of TWENTY-ONE YEARS of Gas Engine Experience, and is built in the LARGEST EXCLUSIVE GAS ENGINE PLANT IN AMERICA.

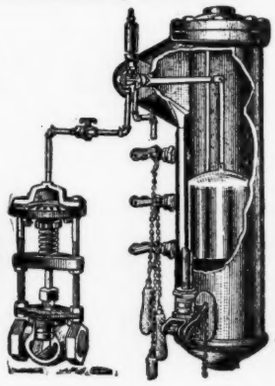
Write today for Free 40-page Foos Book K, which tells why the Foos is the WORLD'S GREATEST ENGINE.

THE FOOS GAS ENGINE CO., Springfield, Ohio.

THE **BERRY**

Safety Automatic

Feed Water REGULATOR

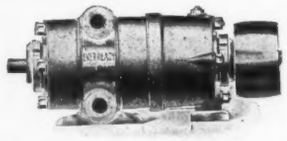


Send for Catalogue

BERRY ENGINEERING COMPANY
Chester, Penn.

Canadian Office, Room 16, No. 17 St. John St., Montreal, Canada.

We Manufacture
AN ECONOMICAL AND DURABLE ROTARY ENGINE



Send for Catalogue.

Ball-Cooley Engineering Co.
316 HUDSON ST., NEW YORK CITY and 159 GREEN ST., BOSTON.

ALBERGER TANDEM GAS ENGINES

ACCURATE REGULATION FOR ELECTRIC SERVICE-AUTOMATIC CUT-OFF AND RITES FLY-WHEEL GOVERNOR

A.H. ALBERGER COMPANY

45 TO 600 H.P. USING NATURAL GAS
35 TO 500 H.P. USING PRODUCER GAS

695-697 ELLICOTT SQ.
BUFFALO, N.Y.

Watson Steam Pump Governor

For maintaining an even water pressure. Should be used on all steam pumps where a fixed discharge pressure is desired. Designed right and made right, it is automatic and reliable. Send for catalogue.

Watson & McDaniel Co.,
Philadelphia, Pa.

OTTO ENGINES

Gold Medal at Jamestown

OTTO OTTO

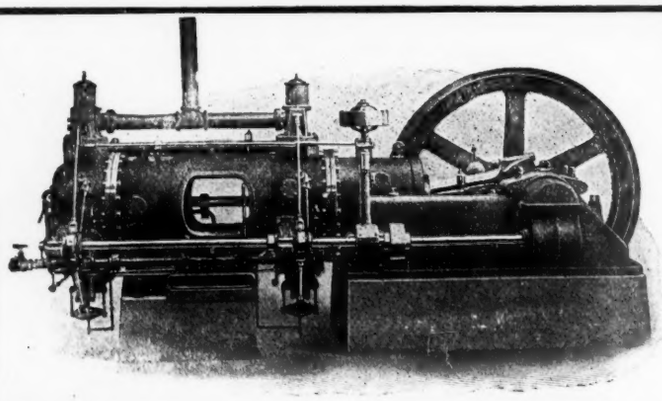
The U. S. GOVERNMENT paid this Company a big compliment when it selected the "OTTO" Engine for use in making fuel tests at the Jamestown Exposition.

The Jury of Awards also proved its fitness for its task when it awarded the "*OTTO*" the *GOLD MEDAL.*

The "OTTO" has won *FIRST PRIZE* at every large Exposition held in this Country since the Centennial in '76.

The Otto Gas Engine Works,
Philadelphia, Pa.

STANDARD OF THE WORLD



WARREN GAS ENGINES

Horizontal and Vertical
Types up to 700 H. P.

NOT AN EXPERIMENT

Economy and Reliability Have Been Demonstrated by Actual Service

FULLY GUARANTEED

For All Street Railway, Electric Light and Power Requirements

STRUTHERS-WELLS COMPANY,
WARREN, PENNA.

New York Office, 26 Cortlandt Street.

Pittsburg Office, 310 House Building.

DU BOIS GAS ENGINES

And PRODUCER GAS PLANTS

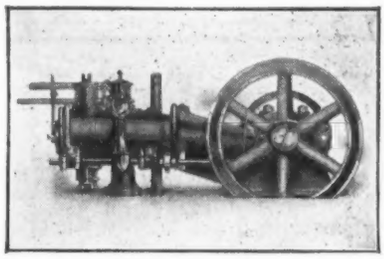
The most improved design, developed under expert experience and a guaranteed commercial success.

In our "5 acres of shop" we have set aside liberal space for the development and extensive testing of all sizes and types of Gas Power Plants we build, which assures successful operation of each installation.

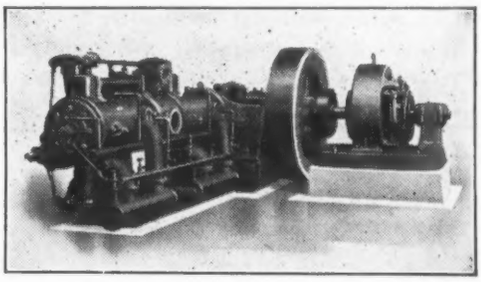
We build engines in sizes 5 to 375 horse power —one, two and four cylinders, single-acting, four-cycle, horizontal types;

Electrical service engines, belted or direct connected to generator;

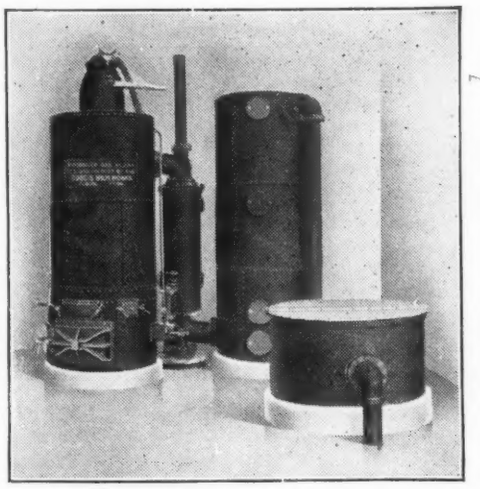
General service engines;



Single Cylinder Throttling Engine
5 to 100 H. P.



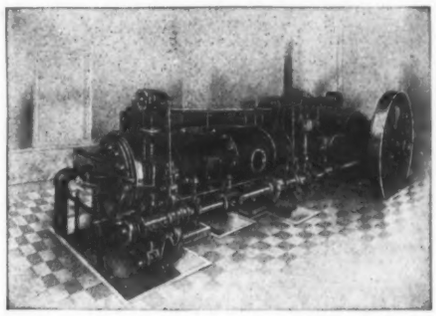
Tandem Cylinder Engines
50 to 190 H. P.



Complete Producer Plant
20 to 375 H. P.

To operate on Natural Gas, Producer Gas, Gasoline.

Write for 1908 *Catalog "E."*



Twin Tandem Types
100 to 375 H. P.

DUBOIS IRON WORKS

Established 1877.

DUBOIS, PA.

Buffalo Pittsburg Baltimore Indianapolis Cleveland

IT MAKES YOUR GAS AN OPEN BOOK

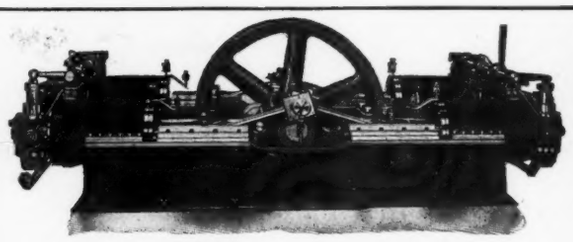
The longer you remain in ignorance as to the heat value of your gas, the more money you stand to lose.

The Sargent Automatic Gas Calorimeter is easy to operate and tells you the necessary things you should know.

CATALOG ?

Sargent Steam Meter Company,

1005 Plymouth Bldg. Chicago, Ill.



For Heavy Duty

the Miller Gas Engine will easily prove itself superior to any other internal combustion engine on the market. It is built in 35, 50, 75, 100, 150 and 250 Horse Power sizes. Every part is designed with a view to strength, reliability and durability. The result is a harmonious combination of efficiency and economy. Catalog on request; write for it to-day.

THE MILLER IMPROVED GAS ENGINE CO.
SPRINGFIELD, OHIO, U. S. A.

A TEST

OF A

LOOMIS-PETTIBONE GAS PLANT

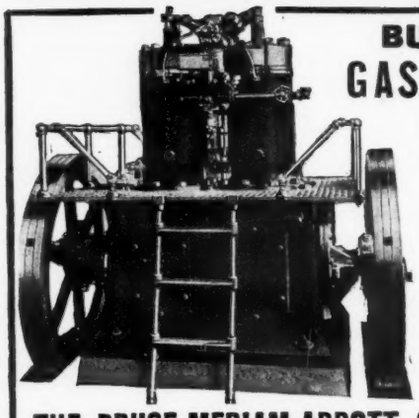
operating a 500 B. H. P Gas Engine, showed on a 51-hr. run a consumption of but 1.4 lbs. bituminous coal per K.W.-hr.

Write for particulars to

POWER AND MINING MACHINERY COMPANY,
(Owners and Exclusive Builders.)

New York Office, 115 Broadway.

General Offices and Works, MILWAUKEE, WIS.



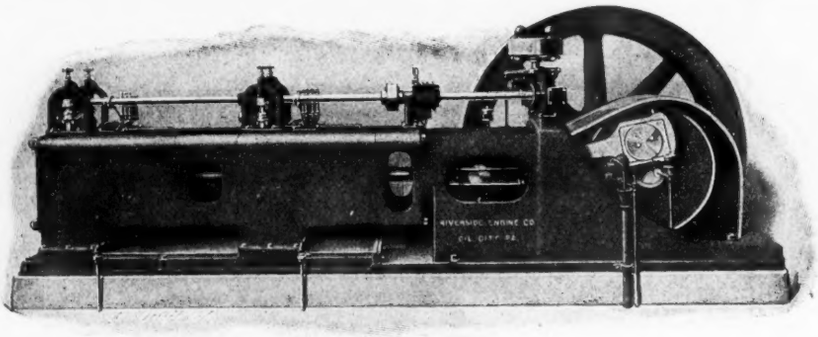
BUY B-M-A GAS ENGINES

for the following reasons:-

THEY ARE EFFICIENT, RELIABLE AND DURABLE.

Write for Catalogs of Producers and Engines.

THE BRUCE-MERIAM-ABBOTT CO. 1692 Columbus Road CLEVELAND, OHIO



Riverside Heavy Duty Single Acting Tandem Gas Engine (Class C)

RIVERSIDE

Engines do not back-fire under any conditions. Crank shaft guaranteed against breakage. No valve repairs. No packings to blow out. Valve-gearing all on top and of the simplest possible form. 110-volt magnetically operated ignition system.

Built in twelve types (seventy-two sizes).

Riverside Engine Co.,
Oil City, Pa.

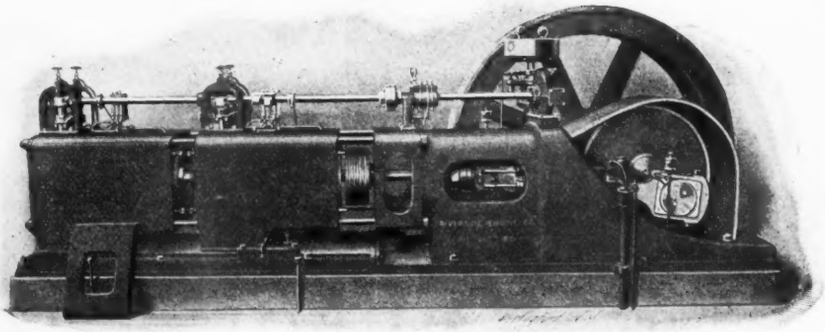
NEW YORK—50 Church St.

PITTSBURG—Keenan Bldg.

FITCHBURG, MASS.—Brown-Russel Co.

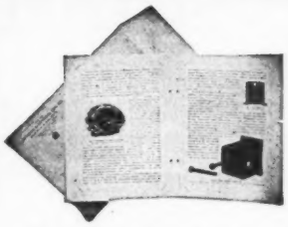
ATLANTA—W. E. Austin Co., Candler Bldg.

INDIANAPOLIS—F. Louis Egan, 1130 Congress Ave.



Riverside Heavy Duty Single Acting Tandem Gas Engine (Class C) Showing Quick Method of Exposing Piston and Rings.

991



MAY WE SEND YOU A COPY?

Bulletin No. 3355 (just issued) is DIFFERENT—full of interesting facts and WORTH READING.
It describes in detail the Best Engine Driven Generator ever offered—the New Northern TYPE L.

NORTHERN ELECTRICAL MFG. CO.,
Standard and Special Electrical Machinery.
MADISON, WISCONSIN.

Your Hand

on a hand wheel controls the Stow Multi-Speed Motor and obtains a wide range of speeds with full H. P. at every speed. It saves a large amount of power and gives perfect service.

CATALOG ?

Stow Mfg. Company, Binghamton, N. Y.

GENERAL EUROPEAN AGENTS
Selig, Sonnenthal & Co., 85 Queen Victoria Street, London, England.

1 to 75 H. P.

2 and 3 Phase.

15 H.P. 220 V. 1200 R.P.M. 3 Phase Motor.

TRIUMPH

direct current apparatus is known wherever electrical machinery is in use.

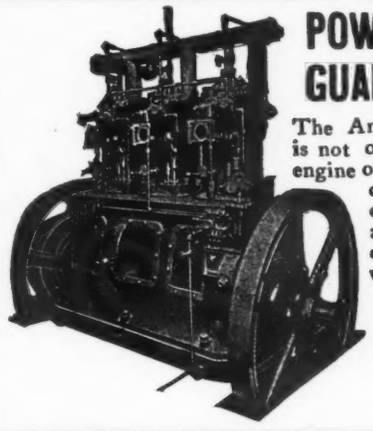
WE have a new line of Alternating Current Induction Motors which will be just as well and favorably known.

Your inquiries are solicited. Ask for Bulletin P-321.

TRIUMPH ELECTRIC CO.

Main Office and Works: Cincinnati, O.

Branches in all large Cities.



POWER COSTS GUARANTEED

The American Diesel Engine is not only the most efficient engine on earth but it burns the cheapest liquid fuel—crude oil. We can guarantee a cost which no other engine can develop under test.

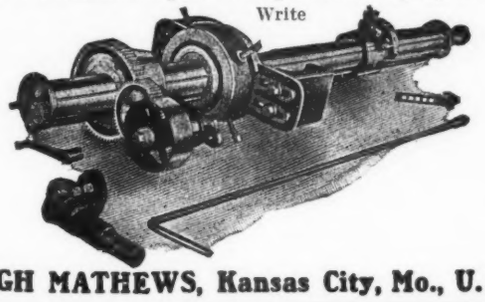
Write for Catalogue.

AMERICAN DIESEL ENGINE CO.
11 Broadway, N. Y.

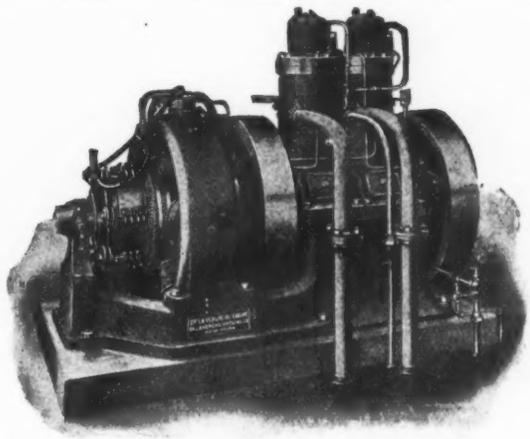
Shutting Down Costs More Than It's Worth

Since with this boring bar you can rebore your cylinder where it stands and pocket the profit on the job yourself.

Write



HUGH MATHEWS, Kansas City, Mo., U. S. A.



For small and medium sized plants our

OIL ENGINES

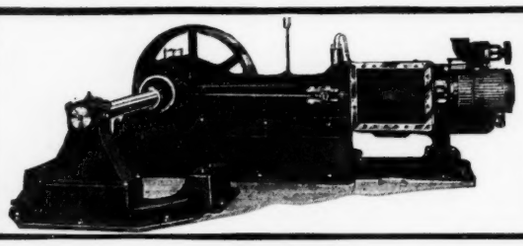
are cheaper, simpler, more compact than any other motive power. 8 H. P. hours per gallon of cheap oil.

5315 H. P. used by Baldwin Locomotive Works

The "De La Vergne" Vertical two-Cycle 4 to 25 H. P.
"Hornsby-Akroyd" Horizontal Four-Cycle 2 1-2 to 250 H. P.

DE LA VERGNE MACHINE CO.

Foot East 138th Street, NEW YORK.



Skinner Engines

have set a new mark for maintained economy, close regulation and perfection of lubrication.

SKINNER ENGINE CO., - ERIE, PA.

CORLISS ENGINES

Simple, condensing and compound, 50 H. P. to 2000 H. P. Complete steam power outfits for every service, Superior in workmanship and performance.

THE BASS FOUNDRY & MACHINE COMPANY,
FORT WAYNE, INDIANA.

A. L. IDE "IDEAL"

Are You Particular?

Do you like to *know* that everything is *right* and as it should be? You get that satisfaction with a

Shepherd Engine.

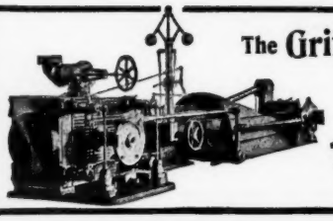
Then there's the economy of operation that comes with quality and workmanship. Altogether, they're a good proposition, and our catalog will interest you.

SHEPHERD ENGINEERING CO., Williamsport, Pa.

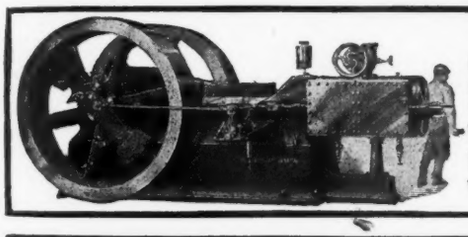
REEVES

Engines have been tried and found true—let us tell you more about them.

REEVES ENGINE & MACHINE CO.
Main Office and Works—Trenton, N. J.



The Griffith & Wedge Co.
Established 1840
Zanesville, Ohio, U. S. A.
Manufacturers of
The Ohio Corliss Engine
and Hoisting Engines

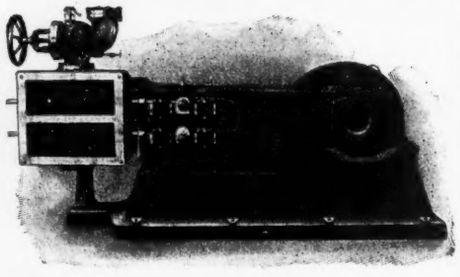


Good Engines
for every power purpose. Ask for Catalog.
Watertown Engine Co.,
Watertown, N. Y.

Speeds To Suit Standard Generators

Chuse Engines are unrivalled for dynamo driving. They are self-oiling, every bearing being flooded with oil from a reservoir, yet not a drop wasted.

Write for other particulars.



CHUSE ENGINE & MFG. COMPANY
MATTOON, ILLINOIS

YOURS On a Minute's Notice

WE HAVE FOR IMMEDIATE DELIVERY:

One 18-inch by 42-inch girder frame engine, left hand, 90 revolutions, rated at 250 h. p; wheel 14-ft. diameter by 48-inch face.

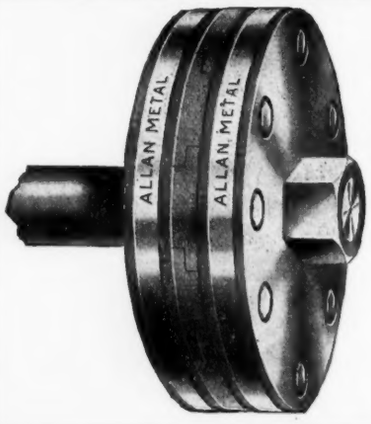
One 19-inch by 42-inch girder frame engine, right hand, 100 revolutions, rated at 280 h.p; wheel 14-ft. diameter by 33-inch face.

The above are new engines.

One 14-ft. diameter by 28-inch face pulley, turned for belt. Hub bored 11 inches diameter. Wheel weighs 15,000 pounds.

Get busy and communicate with us.

C. H. Brown Engine Co.,
Incorporated
FITCHBURG, MASS.



A Piston Faced With Allan Metal

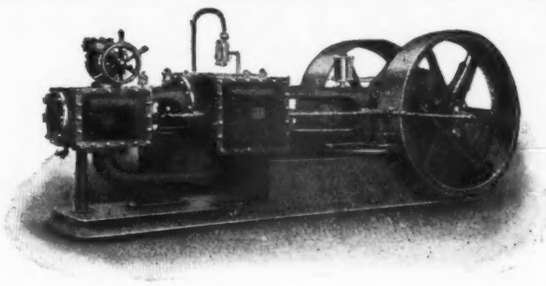
ALLAN ANTI-FRICTION METAL
A. ALLAN & SON, NEW YORK

is bound to give satisfaction under the most unfavorable conditions.

ALLAN METAL will stand the highest pressure and superheat so far practiced. It does not soften under 1500° Fahr.

It is unparalleled as an anti-friction metal.

A. ALLAN & SON, No. 486 Greenwich St., New York.



A COMPOSITE OF PERFECT PARTS

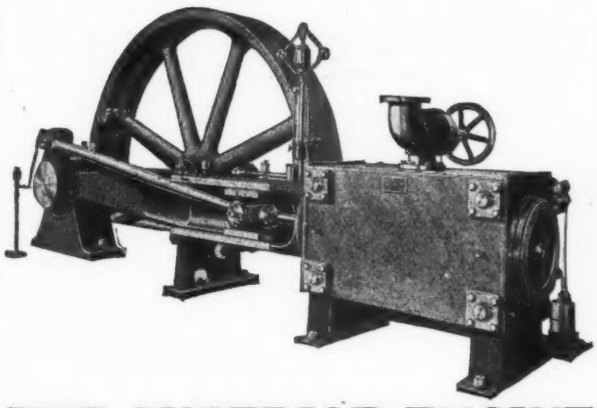
The McEwen Engine

Each part is made to gauge. The valves are perfectly balanced; the regulation extremely close.

McEwen Engines are particularly adapted for driving electric generators. They are built to stand rapid fluctuations of load.

WRITE FOR CATALOG.

RIDGWAY DYNAMO & ENGINE CO.
Works—Ridgway, Pa., U. S. A.



THE SUPERIOR ENGINE

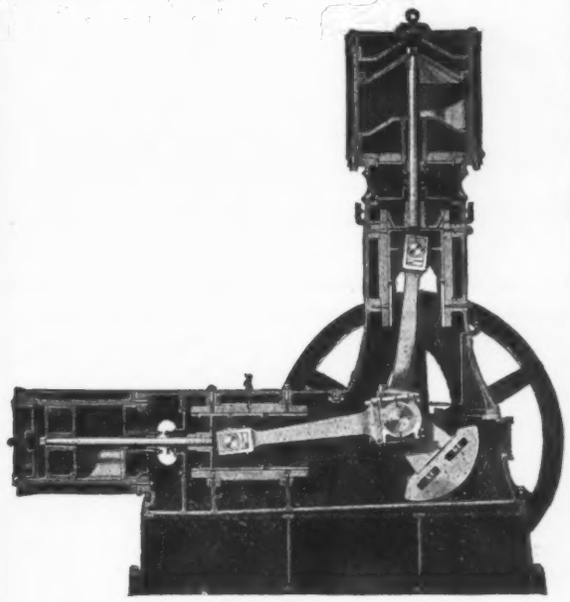
The Harris-Corliss

Built for future needs. The only engine which has the BROWN PATENT RELEASE GEAR, which is the simplest, best and most reliable. It operates without noise or shock. The "Harris-Corliss" is the recognized leader. It gives better "every-day records" than other engines make under special *ideal* tests.

Write today for particulars.

WM. A. HARRIS STEAM ENGINE CO.
PROVIDENCE, R. I.

A PERFECT COMPOUND ENGINE



Engineers have long sought a type of compound engine which could be substituted for the simple automatic engine for driving electric light generators and simple work. The possible steam economy of 25% or so to be gained by compounding seemed to make the quest worth while. However, most of the compound engines proposed for this work have hitherto had shortcomings which overbalanced, at least in part, the advantage of smaller steam consumption.

Tandem compounds occupy too much room and require large foundations. There are no advantages in the way of more even turning moment or better balancing.

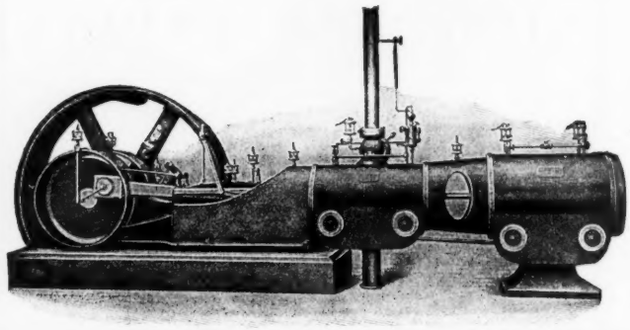
Cross compounds meet with the same objections, but in a more aggravated form, as to expense for foundations and space; further the weight and cost of base castings is practically doubled. Cross compounds are no easier to balance than are simple engines.

The ideal solution of the problem has been arrived at, however, in the AMERICAN BALL ANGLE COMPOUND ENGINE. The floor space occupied is no larger than would be required for a simple automatic engine of the same power. Placing two cylinders at right angles permits accurate balancing in all directions. It is impossible to exactly balance the reciprocating parts in a single cylinder engine without introducing an unbalanced condition in a direction at right angles to the piston travel, but in the ANGLE COMPOUND the balancing is perfect. Two cylinders at right angles give a more even turning moment, and because of this there is less friction upon the bearings and pins and alternators driven by ANGLE COMPOUNDS will run parallel without any trouble and without use of heavy wheels.

If you are in any way interested in engine performance, it will be worth your while to send for our handsomely illustrated Bulletin No. 14, explaining all details of this remarkable engine.

AMERICAN ENGINE CO.,
22 Raritan Ave., Bound Brook, N. J.

"RUSSELL ENGINES"



Four Valve Semi-Corliss—Single Valve Enclosed Self-Oiling and Open Types, Simple and Compound, Belted or Direct Connected, Designed Specially for heavy duty, economy and close regulation.

The Russell Engine Co.,
Massillon, Ohio, U.S.A.

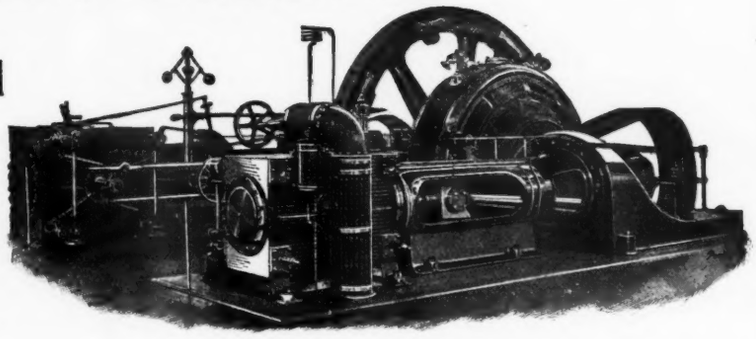
CORLISS ENGINES.

Simple, Tandem and Cross Compound

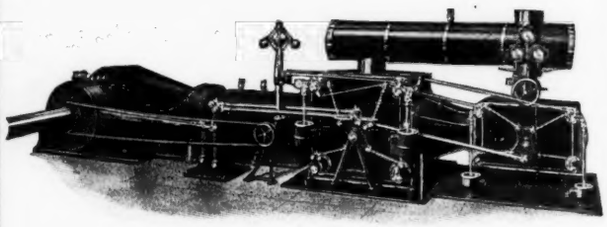
From 50 to 3000 H. P.
Heavy Duty or Girder Frame.

ST. LOUIS IRON and MACHINE WORKS,

Main Office and Works, St. Louis, Mo.
New York Office, 135 Broadway.



Fulton Iron Works, ST. LOUIS, MO., U.S.A.



Builders of Corliss Engines,
Horizontal and Vertical,
Simple or Compound,
Tandem or Cross,
From 30 to 5000 H. P.
Highest Economy of Steam.

PHILADELPHIA OFFICE:
509 Mutual Life Building; Mr. George H. Conner, Manager.

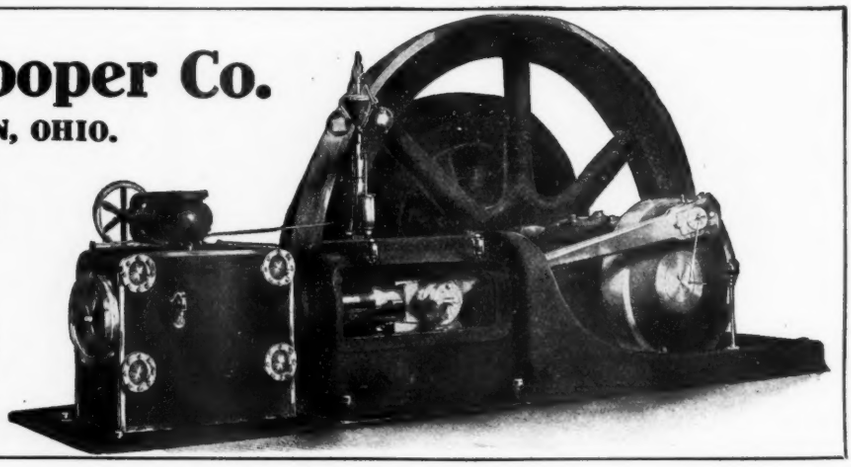
The C. & G. Cooper Co.

MOUNT VERNON, OHIO.

Engine Builders

Branch Offices:

NEW YORK, 918 Bowling Green Bldg.
BOSTON, ... 411 Weld Bldg.
PITTSBURG, ... 604 Frick Bldg.
PHILADELPHIA, . . . Drexel Bldg.
ATLANTA, . . . 310 Candler Bldg.



BUCKEYE ENGINE COMPANY,

SALEM, OHIO

BUILDERS OF HIGH CLASS

STEAM AND GAS ENGINES

HIGH IN DUTY, SUPERIOR IN REGULATION

AND

ABSOLUTELY RELIABLE

CORRESPOND WITH US BEFORE PURCHASING

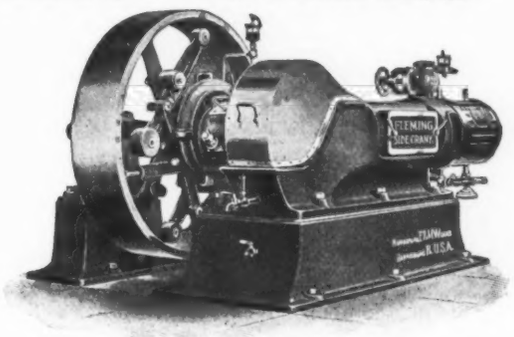
CATALOGS ON APPLICATION

FLEMING-HARRISBURG ENGINES

are known the world over for their satisfactory and economical operation in all kinds of diversified service—built

Simple, Tandem and Cross Compound

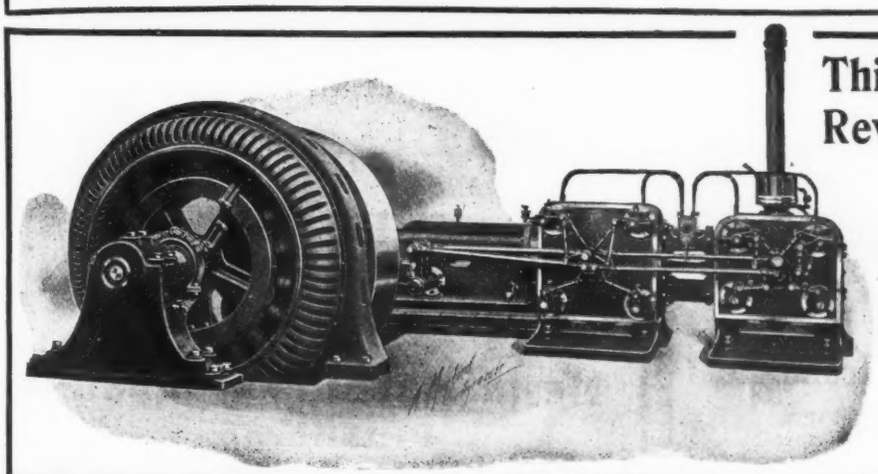
in both **Single and 4-Valve Types**



Harrisburg Foundry and Machine Works,

Harrisburg, Pa., U. S. A.

Selling Offices in all principal cities.



This Engine Runs 200 Revolutions per Minute

High speeds; high pressures; unsurpassed economy; low repairs; the most perfect valve motion; low cost per engine horse power; still lower generator cost. The first Corliss engine we ever built run 26 years at the rate of 11 hours per day. It is still absolutely perfect and is the engine we show prospective buyers. Better investigate our engine records.

CATALOG FREE

CLARK BROS. CO.

Belmont, N. Y.

RICE & SARGENT ENGINES,

CORLISS TYPE.

Horizontal or Vertical, Condensing or Non-Condensing, Simple Cross Compound or Tandem. Designed for Heavy Service of all Kinds, sizes 100 H. P. to 7500 H. P. Releasing Gear Engines up to 1000 H. P. at 150 R. P. M.

FOR HIGHER SPEEDS USE OUR

Four Valve Non-Releasing Corliss Engines,

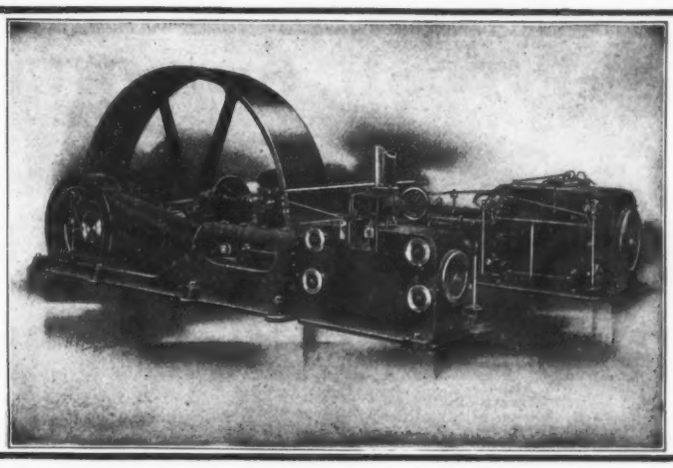
Speeds up to 250 R. P. M.

ALL DESIGNED AND BUILT BY

Providence Engineering Works,

Main Office and Works, PROVIDENCE, R. I.

NEW YORK OFFICE, 42 BROADWAY.



A Few Fine Fitchburg Features

Perfectly balanced piston valves ideal for high steam pressures and superheated steam. Positive adjustment to compensate for all wear.

Automatic governor answers each change of load instantly and positively.

One hour a year will keep the Fitchburg steam tight for 25 years.

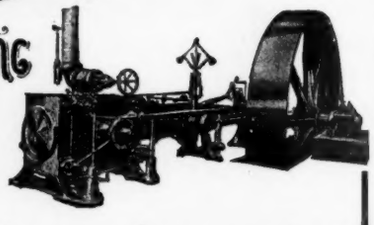
CATALOG?

The Fitchburg Steam Engine Co., Fitchburg, Mass.

E. H. Ludeman & Co., 165 Broadway, New York. H. J. Gebhardt, 1501 Fisher Bldg., Chicago. Geo. H. Connor, 509 Mutual Life Building, Philadelphia. W. C. Tees, Chattanooga, Tennessee.

THE IMPROVED FISHKILL CORLISS ENGINE

BUILT BY THE FISHKILL LANDING MACHINE CO., FISHKILL ON HUDSON, N.Y.



The most efficient and economical power for all purposes.

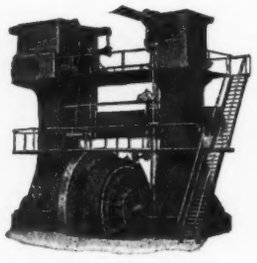
SEND FOR CATALOG.

HEAVY DUTY

CORLISS

AND

Piston Valve Engines



Mesta Machine Company

Pittsburgh

McINTOSH, SEYMOUR & CO., Auburn, N. Y.

ENGINES

VERTICAL, HORIZONTAL.

BELTED, DIRECT COUPLED.

Simple, Compound. Triple Expansion.

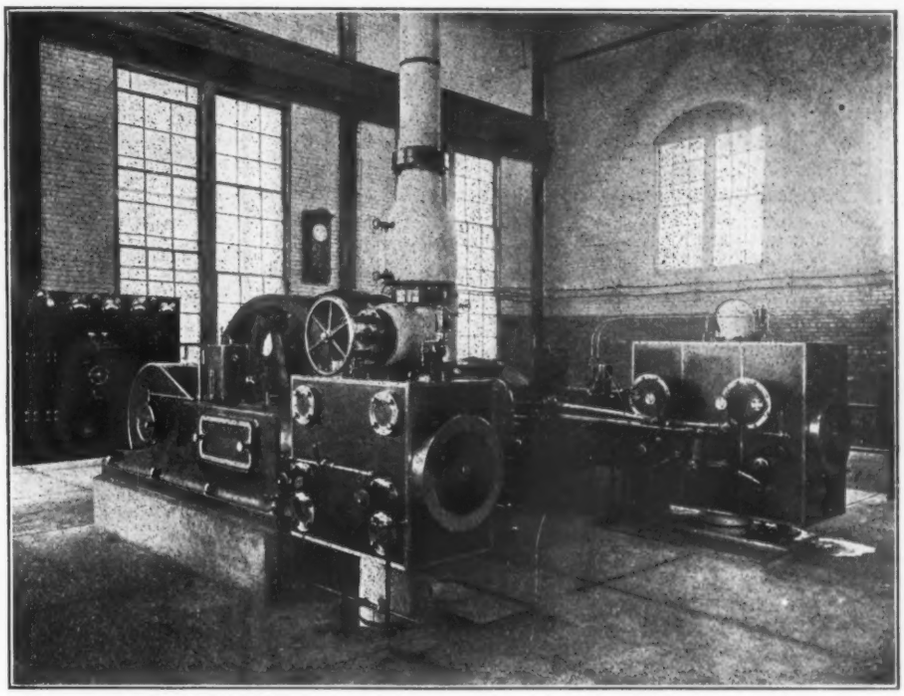
New York: McIntosh, Seymour & Co. 50 Church St.

San Francisco: Charles C. Moore & Co. 99 First Street.

Boston: J. A. Grant & Co. Tremont Bldg.

THE BALL ENGINE CO.,

ERIE, PA.



Cross Compound Non-Releasing Valve Gear Corliss Engine
Direct Connected to Generator, in Dean Electric Co. Plant, Elyria, Ohio.

SALES OFFICES

NEW YORK, N. Y., 39 Cortlandt St. L. COPLESTON, Mgr.
CHICAGO, ILL., 1526 Monadnock Block. W. A. KREIDER, Mgr.
BIRMINGHAM, ALA., 601 Brown-Marx Bldg. H. W. CANNING, Mgr.
PHILADELPHIA, PA., 1001 Arcade Bldg. H. P. PENFIELD Mgr.
ST. LOUIS, MO., 1213 Chemical Bldg. O. L. COLLINS, Mgr.
SEATTLE, WASH., 1112 American Bank Bldg. J. C. CORBIN, Mgr.

STEAM ENGINES

George H. Corliss. **Greene-Wheelock.**

DIESEL ENGINES

Sole Builders For American Diesel Engine Co.

STEAM TURBINES

Sole Builders For Wilkinson Steam Turbine Co.

American & British Mfg. Co.

General Offices—CORLISS WORKS. PROVIDENCE, R. I.

Estimate the Wear

It is entirely a question of "How much wear" that determines the useful life of a prime mover or any other machine. The small Curtis Turbine Generator Set has every advantage over other prime movers on account of the small number and simplicity of parts subject to wear. There is no piston, cylinder, valve or valve mechanism wear to increase leakage and friction, impair alignment and injure perfect valve adjustment with the resulting decrease in efficiency and life. The Curtis Turbine has two or four main bearings, plain and simple, and fully lubricated with clean oil. The few small bearings in the governor mechanism are also fully protected from wear. These are all the wearing parts. There are no internal wearing parts in the Curtis Turbine to cause a decrease in efficiency or make trouble for an engineer.

Estimate the wear and the probable life of the small prime mover with which you are most familiar and mark the contrast with the above conditions.

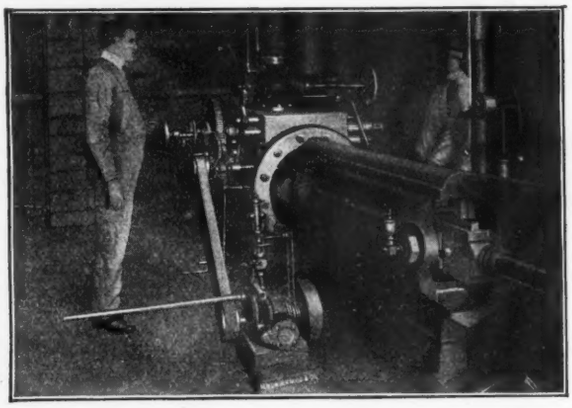
Every steam engineer will gain by making himself familiar with the many practical advantages of the Curtis Steam Turbine Generating Set. It is to his advantage to do so. Modern engineers need modern machinery.

General Electric Company

Principal Office, SCHENECTADY, N. Y.

New York Office, 30 Church St.

Sales Offices in all large cities. 1789



Suppose This Was Your Plant?

The above illustration shows how we'd effect quick repairs.

Send for us the instant engine troubles of any sort occur. We rebore cylinders up to 120" in position, and make repairs that STAY. All our men are *experts* and manipulate their own portable tools. *Don't dismantle your engine.*

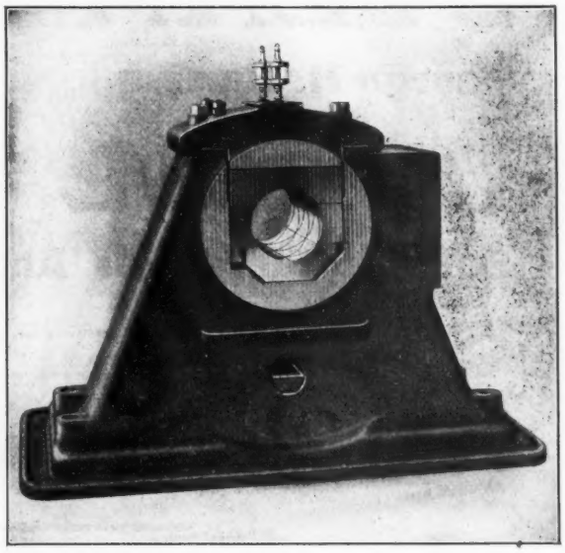
AMMONIA CYLINDERS INDICATED.

H. B. UNDERWOOD & CO.,

ESTABLISHED 1870

1021 Hamilton St., Philadelphia, Pa.

ROLLINS ENGINES STAND CLOSE INSPECTION



Note the consumate strength, weight and rigidity of this Pillow Block This is but one of the many strong parts that go to make the high-efficiency Rollins Engine. Ask for Bulletin 15.

THE ROLLINS ENGINE COMPANY

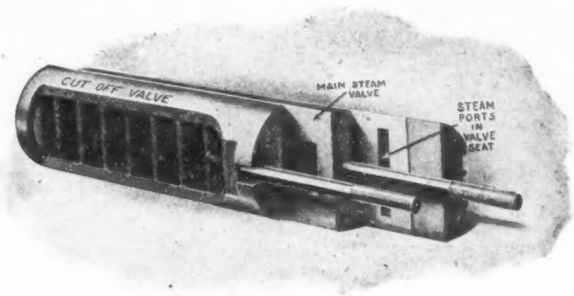
29 Mason St., NASHUA, N. H.

Pacific Coast Representatives—Armstrong-Kreling Machinery Co., San Francisco, Cal.

Why Buy a Sturtevant Generating Set

BECAUSE—the cross-compound engine with gridiron valves (6 for each cylinder) results in efficiency as high as any generating set built in the same size.

BECAUSE—the set requires but little attention and the adjustable parts need be taken up only at long intervals.



BECAUSE—the valves are in the cylinder castings, not in the heads; therefore the pistons may be inspected without disturbing the valve gear adjustments.

BECAUSE—the engines are medium speed, entirely enclosed and equipped with forced lubrication.

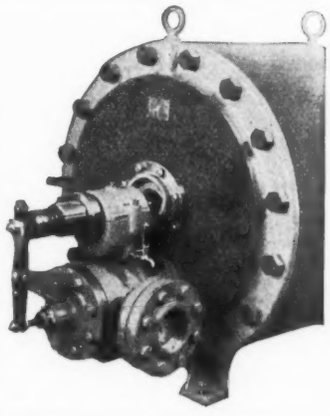
SEND FOR BULLETIN No. 156.

B. F. STURTEVANT CO., Boston, Mass.

General Office and Works, Hyde Park, Mass.

NEW YORK PHILADELPHIA CHICAGO CINCINNATI LONDON

Designers and Builders of Heating, Ventilating, Drying and Mechanical Draft Apparatus; Fan Blowers and Exhausters; Rotary Blowers and Exhausters; Steam Engines, Electric Motors and Generating Sets; Pneumatic Separators, Fuel Economizers, Forges, Exhaust Heads, Steam Traps, Steam Turbines, etc. 688



Quick Delivery — Wide Range of Speed

TURBINE PUMPS for water works, condensers and boilers. Require less steam, attention, oil and space than direct acting piston pumps. Wide range of capacity and head.

TURBINE GENERATORS. Direct current 2 kw. to 150 kw., standard voltages. Alternating current 25 to 250 k. v. a., 60 cycle, standard voltages to 2200. Regulation close.

TURBINE BLOWERS for gas works, foundries and forge shops. No belts or reducing gears. Started or stopped quickly. Capacity up to 100,000 cu. ft. per minute. Pressure up to 16 ozs.

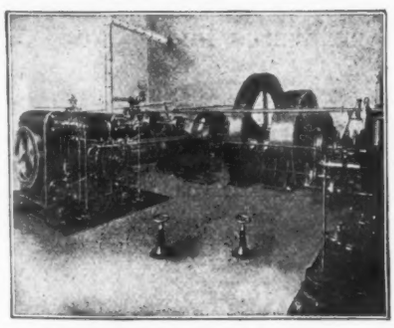
NO OIL IN THE EXHAUST STEAM

Write for Bulletin

KERR TURBINE COMPANY, WELLSVILLE, N. Y.

30 Church St., New York 141 Milk St., Boston 1428 Marquette Bldg., Chicago 320 Second Ave., Pittsburg
1049 Security Bank Bldg., Minneapolis 416 New England Bldg., Cleveland 616 Union Trust Bldg., Detroit

Complete Power Plants.

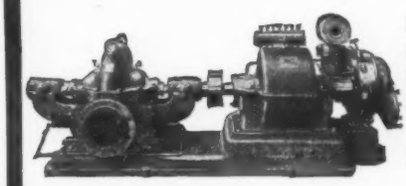


The VILTER Mfg. Co.
854-894 Clinton St.
MILWAUKEE, WIS.

CORLISS ENGINES

ICE MACHINES

DE LAVAL

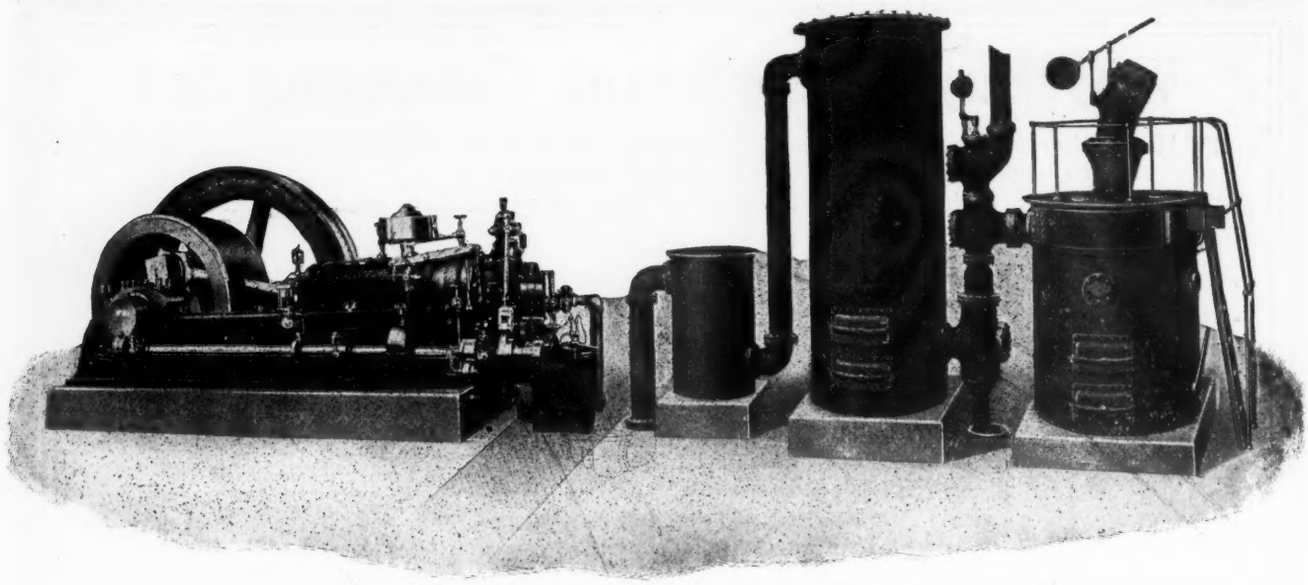


De Laval Turbine-Driven Pump.

Steam Turbine Motors
Steam Turbine Dynamos
Steam Turbine Blowers
Steam Turbine Centrifugal Pumps
Electric-Motor Centrifugal Pumps

Send for Catalog No. 20.

DE LAVAL STEAM TURBINE CO., Trenton, N. J.



Muenzel Producer Gas Power Plant

READ WHAT A FEW USERS OF THE

Muenzel Producer Gas Power Plants

HAVE TO SAY:-

Engineer Electric Light Plant:

"Muenzel plant reliable, dependable and economical power. Better than steam in every way."

Flour Mill Proprietor:—

"Muenzel Suction Gas Power Plant economical and satisfactory power."

Manager Electric Light Plant:—

"Better results could not be expected from any known power than we are getting from Muenzel Suction Plant. Fuel expense less than ½ of a cent K. W. hour."

Factory Superintendent:—

"Muenzel plant has proven very satisfactory in every way, especially financially."

Manager Pumping Station:—

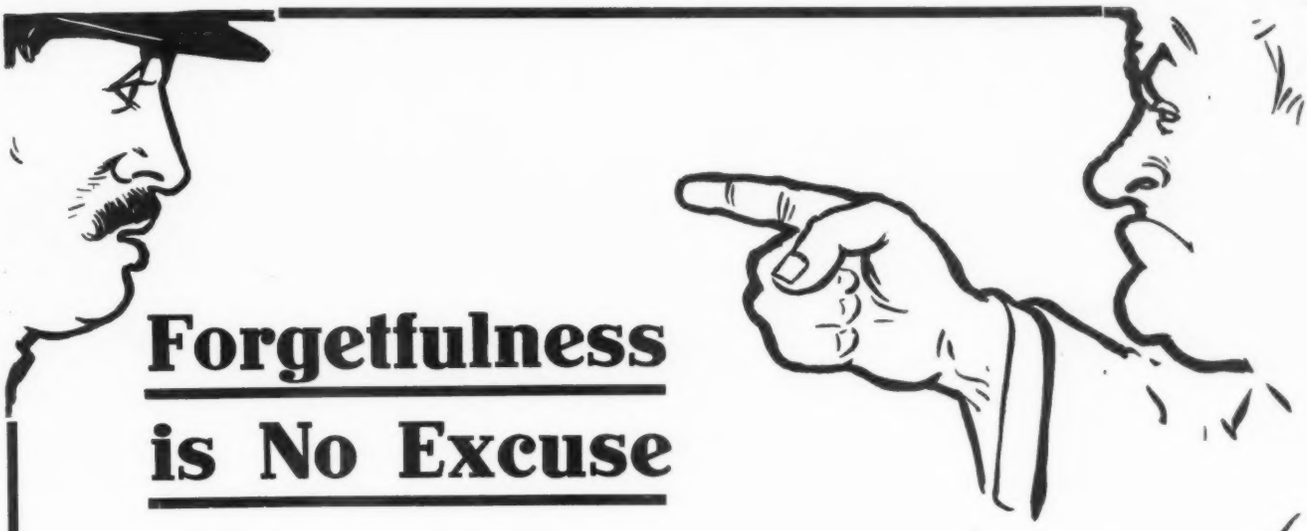
"Cost less than ¼ of a cent per B. H. P. for coal. It works fine. Can highly recommend Muenzel Suction Gas Plant."

60 Plants—aggregating 8000 Horsepower—in successful operation. Ask for Catalog G

MINNEAPOLIS STEEL AND MACHINERY COMPANY

THE LARGEST MANUFACTURING PLANT IN THE WEST

MINNEAPOLIS



Forgetfulness is No Excuse

but it's not always forgetfulness that causes hot bearings where oil is used as a lubricant. Sometimes the oil is used up much quicker than any reasonable being could expect—and that's soon enough as any oil user knows.

However, it's very different with

KEYSTONE GREASE

which lasts about fifty times as long as oil, keeps out all grit and dirt and more thoroughly lubricates the bearing—thus keeping the heat at a minimum degree.

Unaffected By Heat and Cold

Keystone Grease does not melt and run away, as it does not become an oil under 300° F., and it loses none of its power of lubrication in extreme cold. It makes large savings certain in any plant. Are you getting them?

KEYSTONE
TRADE MARK
REGISTERED U.S. PAT. OFF.

See our advertisement on page three.

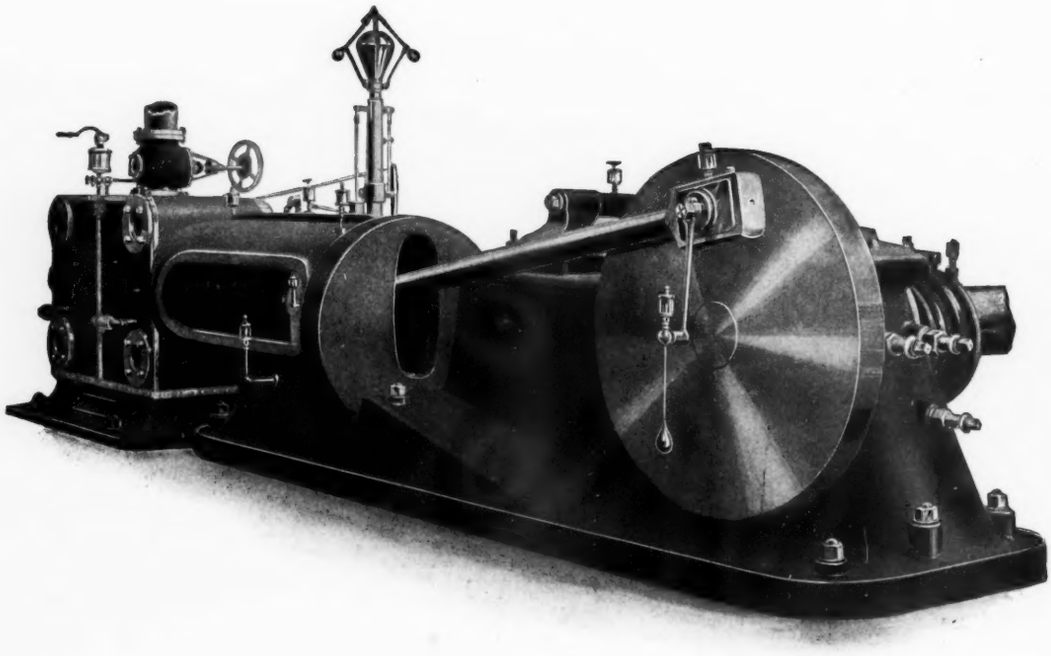
KEYSTONE LUBRICATING COMPANY,

Department B.

PHILADELPHIA, PA.

New England Office, 10 Oliver St., Boston, Mass.
Chicago Office, 1210 Tacoma Bldg.
Northwestern Office, 502 McPhee Building, Denver.
Southern Office, 610 Chartres St., New Orleans, La.
New York City Office, 96 Warren Street.
San Francisco Office and Warehouse, 268 Market Street.

There is Only One Engine and That is the Corliss
There is Only One Corliss and That is the Murray



MURRAY IRON WORKS COMPANY

Incorporated Feb. 1, 1870

BURLINGTON, IOWA

Murray Corliss Engines Save Steam, Steam is Coal and Coal is Cash